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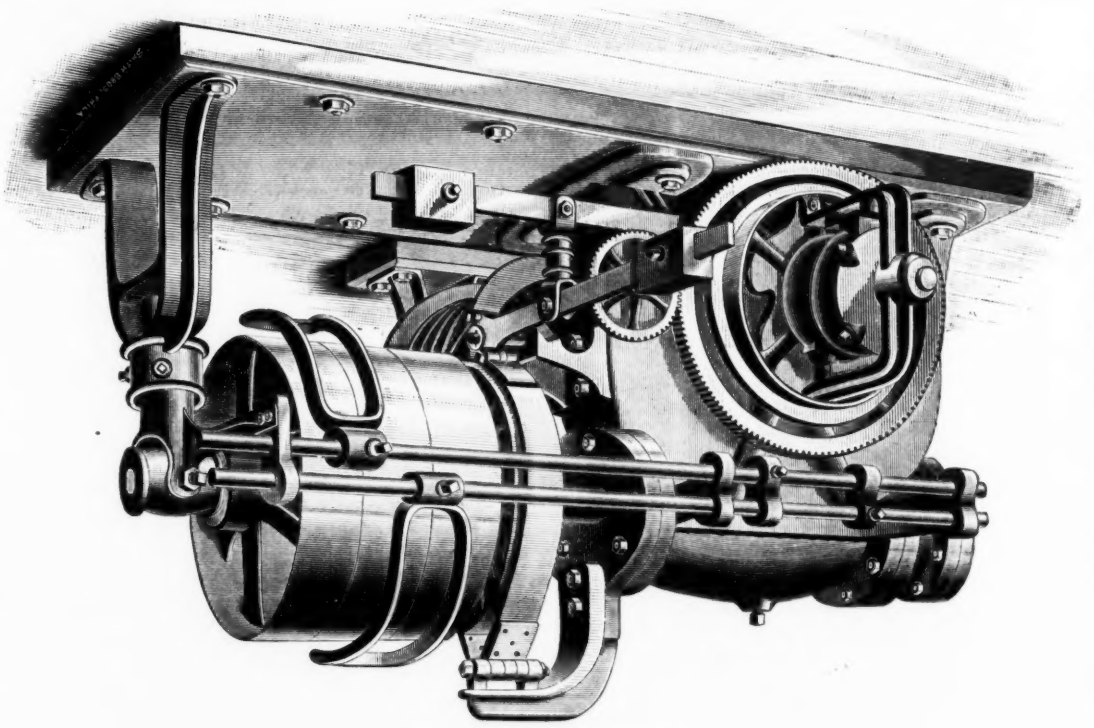
The Albro-Clem Elevator.

Our first illustration on this page is of the winding mechanism of a new elevator built by the Albro Clem Elevator Co., 411–413 Cherry street, Philadelphia, Pa.

The main distinguishing feature of this elevator lies in the fact that it uses the well-known Albro worm and wheel, regarding which and its manufacture we shall have something further to say in an early following issue. At present it is sufficient to say that it gives about three times the wearing surface obtained by other systems of worm-gearing, and that the relative motion of the surfaces of the worm teeth and of the worm are such that the lines of wear cross and recross each other, thus preventing the formation of grooves, and actually causing a polishing action, the durability and freedom from destructive friction being remarkable.

An improved belt-shifting device is applied which shifts one belt entirely off the driving pulley before the other one is run on, and there is a band brake which is automatically applied whenever neither belt is on the driving pulley and which is sufficiently strong to hold securely the entire load which the elevator is designed to carry should it be called upon to do so. The power which applies this brake being derived from weighted levers, the brake is self-adjusting.

There is also a new reversing attachment by which, should the downward motion of the car or platform be for any reason obstructed, the motion of the drum is automatically and instantly reversed, thus doing away with the possibility of the unwinding of the cable without corresponding descent of the car; an accident which has been the cause of much trouble and of many serious accidents with elevators. The device is in this case entirely self-contained and is composed of positive acting mechanism.



THE ALBRO-CLEM ELEVATOR.

The winding drum is turned and grooved in the lathe, thus insuring accuracy and smoothness, conducing to long and satisfactory wear of the cable. The principal working parts of the elevator, such as the worm and wheel with their bearings, and the loose pulleys are made self-oiling, the worm and wheel being inclosed in an oil-tight case filled with lubricant. The machine is regularly made with capacities of 2,000, 4,000 and 6,000 pounds, and is made also to stand on the floor where it is preferable to so arrange it.

There are rumors that a powerful syndicate of capitalists are considering the erection of a plant which will be able to compete with the combined Carnegie interests. Pittsburgh and English capitalists are said to be interested, and they declare they do not care where the new works are located. It will be simply a question of convenient and cheap fuel and materials with concessions of land, etc. At present there is no concern in this country that can in all lines compete with Carnegie's. Their rail plant, for instance, being much ahead of any other.

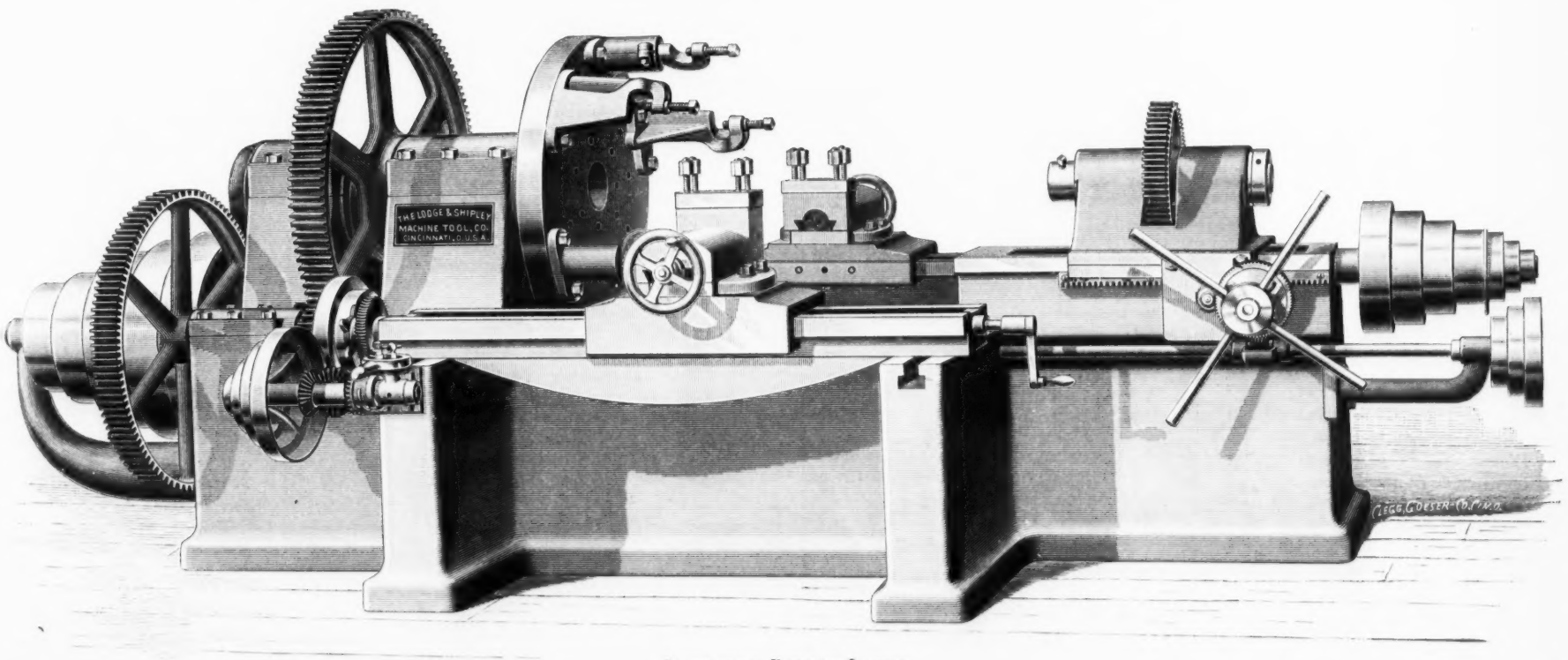
Sixty-inch Pulley Lathe.

The second illustration on this page is of a new pulley lathe designed to turn and bore simultaneously pulleys up to 60″ diameter and 36″ face.

In the construction of this machine, the aim has been to secure the greatest solidity and driving power, and to this end the bed from the floor or foundation to the main spindle bearing is made in a single casting, the spindle being 10″ diameter, with a 6″ hole through it, and driven by a 5″ belt running on a six-stepped cone pulley, which is so geared as to make 60 revolutions to one of the spindle, the main driving gear being equal in diameter to the full swing of the lathe. The spindle is scraped to bearings in the head.

The rails upon which the carriages are mounted are supported upon extensions of the bed, which extend in vertical lines to the floor, and the rails can be set at any desired angle for crowning pulleys. On the back rail, power cross and angular feed is provided.

A bushing is placed in the outer end of the live spindle to support the boring bar at this point, the bushing being provided with a self oiling device. The boring bar being independently driven, a proper speed may be secured for this, and it may be varied to suit reaming or other purposes. The boring bar is fed either by power or by hand, the latter by means of the pilot wheel. Pulleys may be placed upon an arbor for turning after being bored if preferred, and, where it is desired, the machine is furnished with a plain foot-stock for turning upon centers. Weight of machine, as shown, is 20 000 pounds. It is built by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.



SIXTY-INCH PULLEY LATHE.

Main's Patent Hot Blast on the Steamships "Seguranca" and "Vigilancia."

In consequence of the very high price of coal on the Brazil coast, and the desire of the directors of the United States & Brazil Mail Steamship Co. to reduce the amount of their coal bill, they resolved to apply T. Main's patent system of hot blast to the steamships of their line, and accordingly in July, 1888, this apparatus, as illustrated in our issue of March 7, 1889, was fitted to their steamship "Advance."

In January, 1889, it was fitted to their steamship "Allianca," and in March of the same year the apparatus was fitted to their steamship "Finance." Of late, this apparatus has been improved, as indicated in the accompanying sketches.

On the voyage from New York to Rio Janeiro, Santos and return, of the steamship "Advance," from May to July, 1888, before the hot blast was fitted on board, the engineer's log-book shows that the consumption of coal when under way was 32 tons per day. While on the succeeding voyage, from July to September, 1888, after the hot blast had been fitted on board, the consumption of coal per day was 28 tons going south, and when coming north, after the apparatus had been adjusted somewhat, and the firemen had become accustomed to the new system, the consumption of coal was 22½ tons per day, the speed of ship and the amount of cargo being about the same as on the preceding voyage.

When the apparatus was kept in proper order, and the firing properly attended to, this result could always be obtained.

Similar results were produced on the steamships "Allianca" and "Finance."

Towards the end of the year 1889, after the great saving of coal on their steamships had become apparent, the United States & Brazil Mail Co. ordered the two new steamships "Seguranca" and "Vigilancia," and they were also fitted with Main's hot blast system. The "Seguranca" went to sea in September, 1890, and the "Vigilancia" in December of the same year. These ships were 320 feet long, 45 feet 3 inches beam by 27 feet 3 inches deep, and 2,850 tons register.

They were fitted with triple-expansion engines; cylinders, 28 inches, 44 inches, and 70 inches diameter by 4 feet stroke, and made from 63 to 70 revolutions per minute, with a steam pressure of 160 pounds.

There were no steam jackets on any of the cylinders. Consumption of coal when under way, 38 tons per day. Indicated horse-power, 2,760. Consumption of coal per horse-power, 1.28 pounds per hour.

There were six cylindrical boilers, and 12 furnaces, with 270 square feet of grate surface.

The general arrangement of the hot blast, slightly modified as regards the blower, is shown by Fig. 1. The arrangement of the furnace fronts is shown by Fig. 2, and the steam fan blower arrangement is shown by Fig. 3.

It has been demonstrated that for moderate blast pressures the fan blower is as effective as other pressure blowers, while it is not so bulky, nor so costly, and it weighs much less.

The object aimed at in this hot blast is to control the combustion of the coal in the furnace, by means of closed furnaces and artificial blast, without reference to the condition of the atmosphere, the wind, or the height of the smoke pipe or chimney, and also to utilize the heat of the waste furnace gases and return it to the furnaces, in the air which supports combustion.

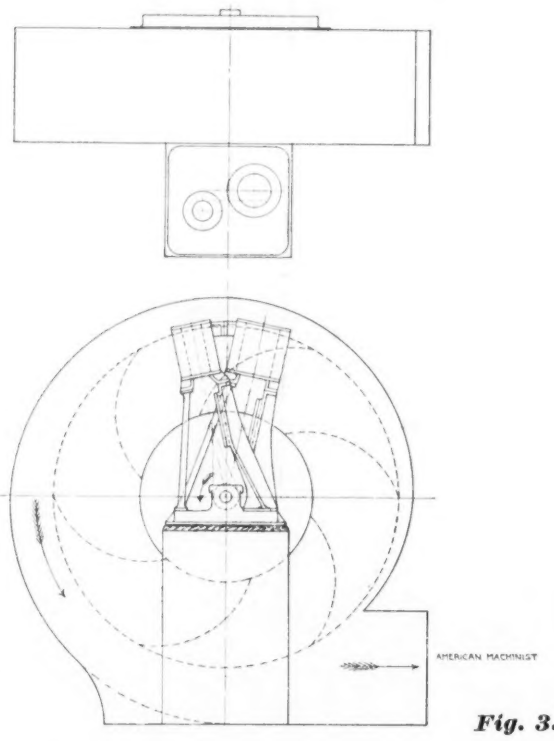


Fig. 3.

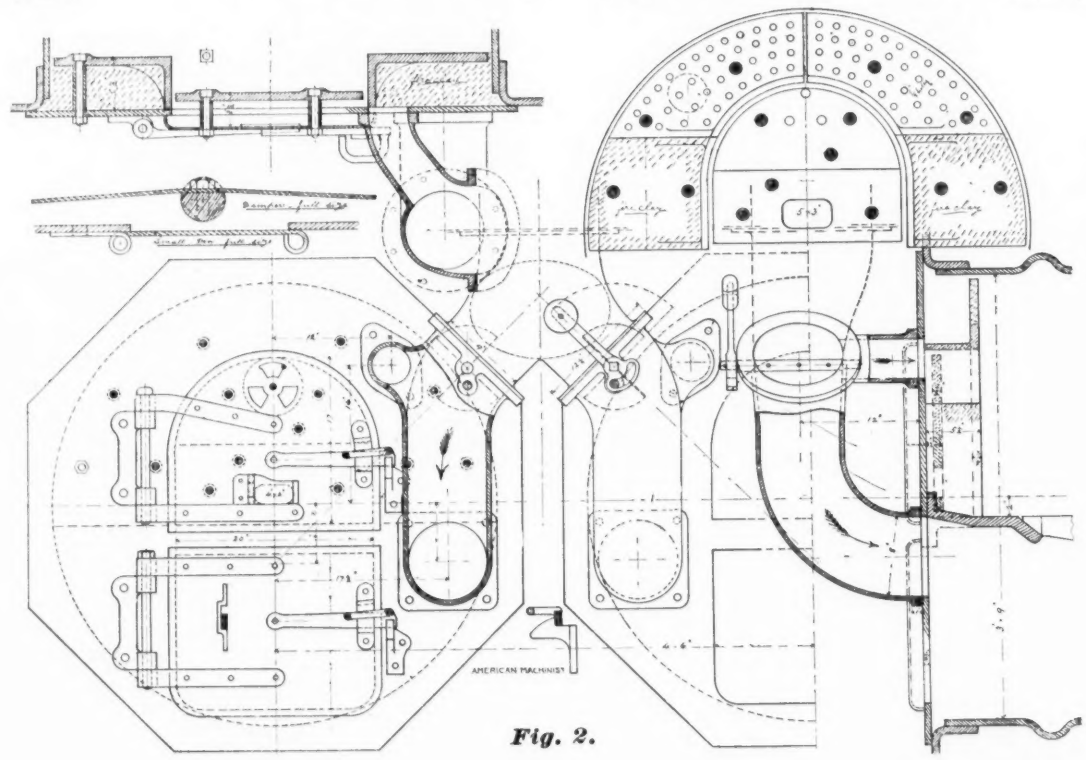


Fig. 2.

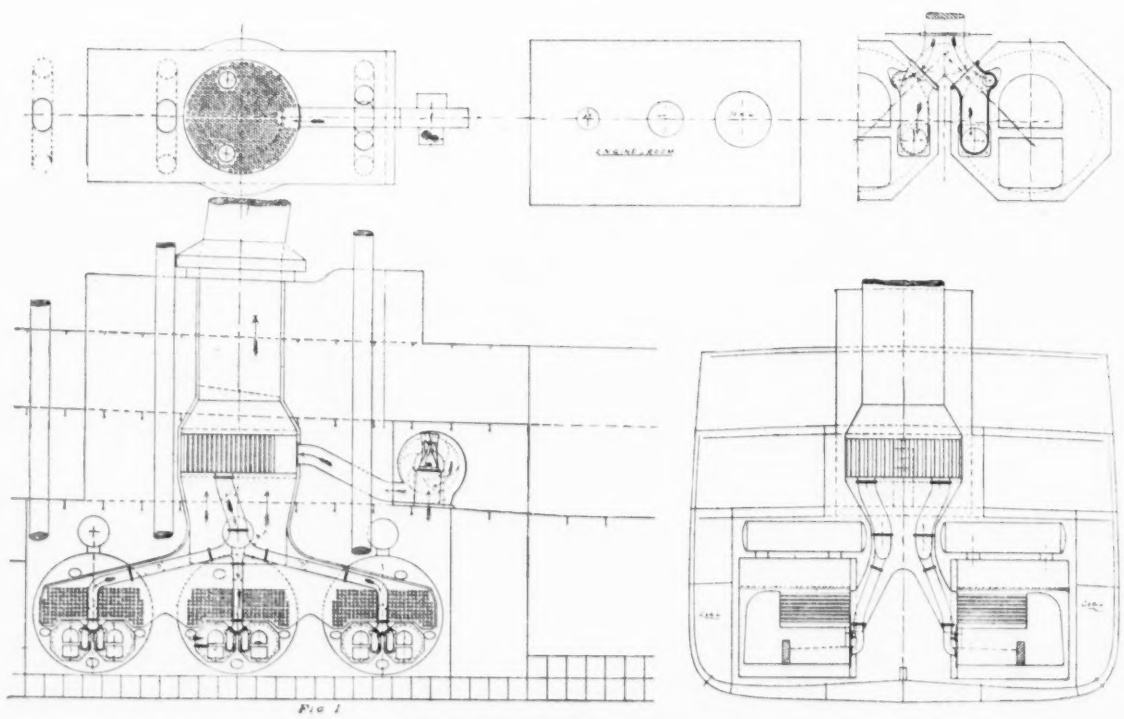


Fig. 1.—Main's Hot Blast.

It will be observed from the illustration that the waste furnace gases, and the air to support combustion, move in opposite directions, and consequently, that while one decreases in temperature, the other increases. It was found that the temperature of the waste furnace gases below the air heater was 700 degrees, while above the heater it was only 450 degrees. It was also found that the temperature of the air drawn from over the after boilers, and from the engine room, was 115 degrees, while it was delivered into the furnaces at a temperature of 300 degrees, consequently all the heat necessary to raise the temperature of the air from the fire room temperature up to 300 degrees was saved.

It will further be observed from Fig. 3, that the air is supplied to the ash-pit by an 8-inch pipe, while a 4-inch pipe supplies the furnace above the grate; consequently 80 per cent. of the air goes under the grate, and 20 per cent. above.

It is stated that when the furnace is properly manipulated a very perfect combustion of bituminous coal is obtained, and scarcely any smoke is perceptible.

With this system there is no danger of causing leaky tubes; there is a valve to shut off the air before opening the furnace door, and when open there is nearly an atmospheric balance at the door, so that no cold air enters the furnace, and no hot gas comes out. Then there is no trouble in consuming as much coal on the grate as may be consistent with producing good combustion at the same time.

For it should be remembered that three operations go on in combustion—first, the combustible gas has to be liberated or evolved from the coal; second, the air and combustible gas have to be mixed; and third, combustion of the gas has to be effected before it enters the tubes and becomes reduced below the temperature of about 1,000 degrees.

If combustion is too rapid, sufficient time does not elapse to allow these operations to be effected.

The air above the grate is first admitted into the hollow furnace front, then through the perforated front lining into the furnace in fine streams, in order to facilitate the mixing with the combustible gases in the furnace before combustion.

The blower shown in Fig. 3 is arranged with curved blades or vanes, as in the Appold pump and Lloyd blower; it is of large diameter, and driven by Main's patent balanced compound engines.

On account of the long voyage, and the mail contract with the Brazilian government, the company found it practicable to keep their ships in New York only from 7 to 10 days, and during that time nearly all repairs had to be made, which allowed very little leisure or rest for the crew, and, in consequence, the engineer's crew were changed often, the firemen being nearly all new every voyage.

Owing to this state of things, Capt. J. M. Lachlan, the general manager for the company, found some difficulty in having his orders carried out, to keep the hot blast apparatus in repair, and to have the furnaces properly manipulated, yet there was no real difficulty in the matter, and the apparatus worked successfully for about three years on the three older ships, and one and a half years on the two new ships, and saved a great amount of coal, while he controlled the business of the company.

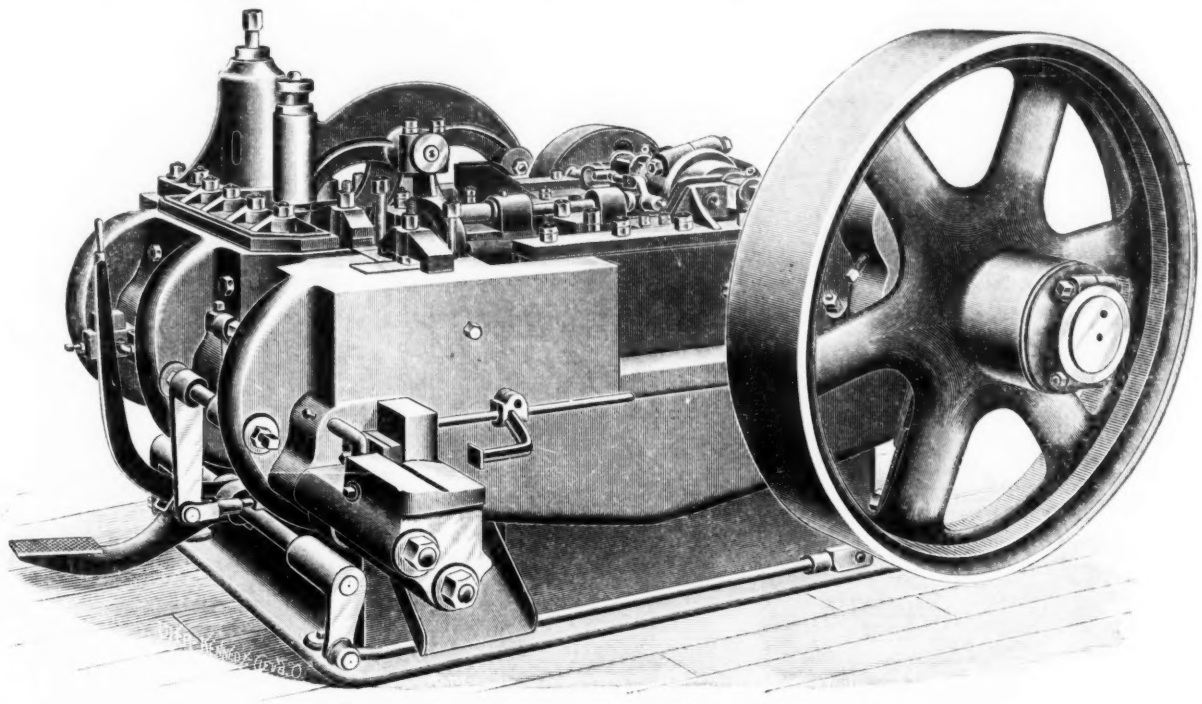
This hot blast apparatus was also applied in 1890 to the steamship "San Benito," belonging to the Pacific Improvement Co., and this vessel, at last accounts, was running successfully on the Pacific Ocean, and effecting a saving of from 20 to 25 per cent. of coal, due to the hot blast apparatus.

The accompanying illustrations were taken from designs by Mr. T. Main, 1304 Garden street, Hoboken, N. J.

Bolt-heading, Upsetting and Forging Machine.

The accompanying engraving is a machine designed to head bolts, and for all forging work of a similar character. The bed is made in the box form, with three deep trusses running through its entire length to give it great strength. The crankshaft, which is made of the best forged iron, is carried in three bearings, the face of the bearings being inclined towards the front of the machine, thus bringing the thrust of the forging tools and die closing mechanism against solid metal, and relieving the main caps and cap bolts from all strain. None of the parts subject to wear slide directly upon the bed of the machine, but upon steel and phosphor bronze strips or guides, which may readily be removed to be trued up or replaced, thus saving the trouble and expense of dismantling the entire machine and taking it to the machine shop, should repairs be made necessary by such wear as does take place. The machine is also provided with a cushion clutch stop motion, so that when making special forgings one or more blows can be given, as may be required to finish the work. The dies and punches are of novel construction, and will turn out perfect square and hexagon bolts in three blows, or a revolution of the machine. Rivets, track bolts, and many other forgings are made off the rod, and cut to length by a shear provided in the rear of the dies. An outside shear is provided for, which can be used for cutting up stock, or for cutting off work from the bar after forging. A patent relief wedge serves to prevent the breaking of the bed through the feed gap, should the operator allow cold work to get caught between the dies.

This illustration is from what is called the two-inch machine, and its weight complete is about 30,000 pounds. It is made by the Acme Machinery Co., Cleveland, Ohio.



BOLT-HEADING, UPSETTING AND FORGING MACHINE.

On the Cultivation of Inventive Capacity by the Solution of Constructive Problems.

BY LEICESTER ALLEN.

Numerous other solutions of the problem given out in the issue of the AMERICAN MACHINIST for December 29, 1892, have come to hand. Some of these resemble those already published. Others show that a greater variety of solutions is possible without overstepping the restrictions than I at first thought could be the case.

The first of these possibilities that I shall select for the present article has been contributed by Mr. Charles L. Graves, of Bridgeport, Conn., a State in which mechanical ingenuity, like the rocks, seems to be one of the staple productions of the soil. This solution is shown in Figs. 1, 2, 3 and 4; or rather, that which I shall accept as a solution is shown in Figs. 3 and 4, while Figs. 1 and 2 show a method of effecting the movement that, while it violates one of the restrictions, is so simple and mechanical that I deem it worthy of notice, and I think it might be used for other purposes than that which originated the problem.

Mr. Graves, in explanation of his movement, says: "Fig. 1 is a side elevation and Fig. 2 a plan view. The axis of the roller *a* in the fork *b* is placed at an angle with the shaft. In operation, the roller *a* being brought up against the shaft by the nuts on the fork *b*, sliding the stock will revolve the shaft one way in going forward, and the reverse in coming back."

I think Mr. Graves had some doubts that by this construction he might have overstepped the restrictions, for he adds that "this construction will necessitate a slot in the bottom of the stock large enough to clear the nut." But he shows another construction in Figs. 3 and 4, whereby the slot may be avoided. Fig. 3 is a partial plan and Fig. 4 an end view illustrating the variation proposed, but involving the same principle as shown in the first construction. In the variation the roller is carried by a bracket supported by the table.

Fig. 1

Fig. 2

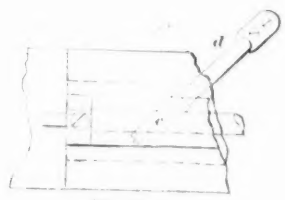


Fig. 3

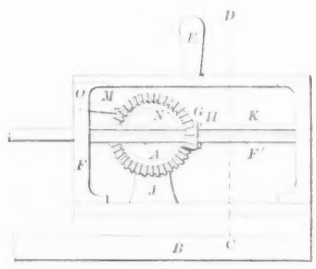


Fig. 5

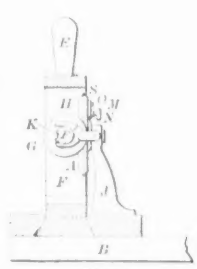


Fig. 6

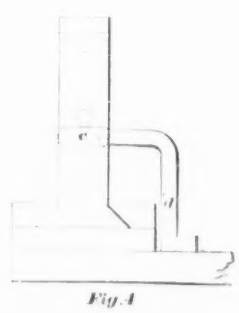


Fig. 4

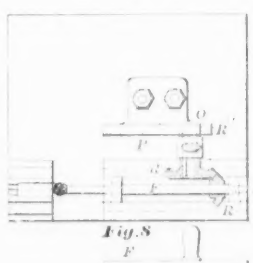


Fig. 8

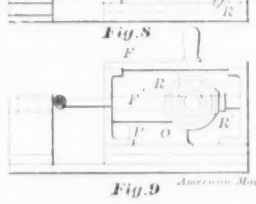


Fig. 9

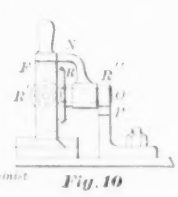


Fig. 10

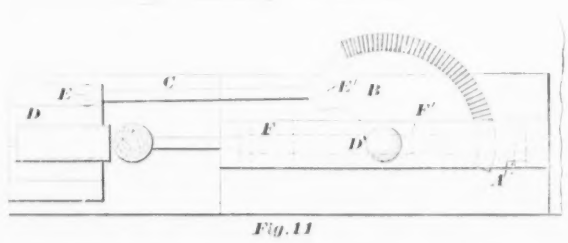


Fig. 11

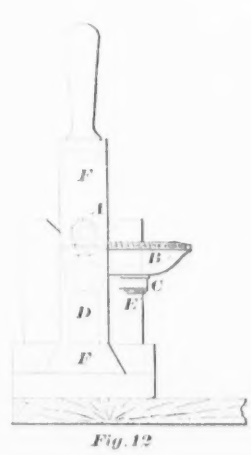


Fig. 12

This latter movement satisfies the conditions of the problem, provided it can be shown that the sliding of the stock will give a sufficient number of turns with any practicable angle of inclination of the axis of the roller to the axis of the shaft; but it may easily be conceived that only a very moderate movement of rotation in a shaft moving longitudinally would be all that would be required for some uses, and the device of Mr. Graves shows a very simple way of doing this.

Mr. Graves has forwarded another solution which seems identical with the second one given by Mr. Gribben in the previous article, and I do not therefore give a drawing of it.

Figs. 5 and 6 illustrate a solution sent in by Mr. Leo Rebay, of Jersey City, N. J. In the figures *F* is the sliding stock and *F'* the spindle, with a key-way *K*, to which a bevel wheel *G* is loosely keyed, so that when *G* revolves the spindle revolves with it, but when the spindle moves forward and backward *G* is not compelled to follow. *J* is a rest supporting a bevel wheel *A* which turns *G*. The bevel wheel *G* is held in gear with *A* by means of the fork *H*, attached to the rest *J*. The link *M* is attached by the pivot *O* to the sliding stock *F*, and by the set-screw *N* to the gear *A*, which permits regulation of the length of the link.

It will now be seen that if *F* be slid forward, *N* will partly revolve *A*, which, in turn, will revolve *G* and the spindle *F'*, and if *F* be then slid backward, the same motions will follow, but in the reverse direction, these being the required motions of the problem.

Mr. Rebay states that when he had made this solution, he thought it might conceal a crank movement, which he seems to think is prohibited. A bell crank movement was stated not to be admissible; and I do not feel certain that the gear arranged to partly rotate back and forth on its bearing, as shown by Mr. Rebay, does not so far approach a bell crank in form and function as to justify its rejection as a solution of the problem. However, I think I will admit it, as it is a good mechanical movement, and I would rather err on the liberal side than throw out any solution on a mere doubt.

In sending in an alternative solution for use, in case this view should be held, Mr. Rebay uses what is substantially and unmistakably a rack and pinion movement, which was expressly excluded. I therefore do not present the movement proposed as a substitute.

Mr. Benjamin F. Soper, of Brooklyn, N. Y., sends in an excellent and mechanical solution, and he writes a very pleasant letter therewith commending these problems, a commendation which I particularly value, as Mr. Soper, being a foreman in a manufactory of a prominent type-setting machine, where demands upon inventive capacity are frequent, is in a position to judge well of the value of this kind of training.

His solution is illustrated in Figs. 8, 9 and 10, which are, respectively, a plan, side view, and end view of the device. Mr. Soper's sketches were quite rude; but I hope he will be satisfied with my interpretation of them, as shown in the figures.

An arm or bracket *N* is attached to the stock *F* and supported by the top of the stock (also by the bottom, if thought necessary). Through a bearing at the extremity of this arm passes a short shaft *O*. One end of this shaft rests upon a rail *P* that has a foot bolted to the table. The other end of the shaft *O* carries a friction wheel *R* that engages a small friction wheel *R'* on the spindle *F'*. The end of the shaft *O* that rests on the rail may have a small friction wheel *R''*, also to run on the rail, if preferred, which will give it more leverage as compared with the wheel *R*, but will, of course, reduce the number of turns made by *F'* for any distance through which the stock is made to slide. If in sliding the stock, the operator presses the handle toward the rail, any tendency for *R''* to spring away from the rail will be prevented.

I consider this an excellent device for the purpose. The wheel *R* may be made considerably larger in proportion to *R'* than is shown in the figure, and thus the number and velocity of the rotations can be much increased. In designing the apparatus (in view of the fact that very little power is needed to turn the spindle *F'*) the friction wheel *R* can be made very light. I think a wooden wheel faced with leather would answer every purpose.

Mr. Frank X. Kibitz, of Buffalo, N. Y., submits the solution shown in Figs. 11 and 12. This solution has a similarity to

the second solution of Mr. Wright, printed in the issue of February 23. It is subject to the same criticism as that of Mr. Wright, to wit, it may be considered as concealing a bell-crank movement, which was excluded in the conditions of the problem. Nevertheless I reproduce it, as it is almost exactly identical with the device I finally adopted, as will appear from a comparison of what was said about that in my previous article with the drawings and description forwarded by Mr. Kibitz.

The solution is reached by the addition of six parts to those shown in the original statement of the problem, to wit, a bevel pinion A, a toothed sector B, a stud bearing D' for the sector inserted in the bottom of the sliding stock F, a connecting rod or link C connecting the sector with the rest D, and the pins E E' which, as they are not mere fastenings but working parts, must also be counted.

Having referred to Mr. Wright's second solution in discussing the solution of Mr. Kibitz, I take this opportunity to apologize to Mr. Wright for an omission to note a special feature pertaining to his first solution that escaped my attention in preparing my previous article, and which distinguishes it from any other solution employing a belt or cord that has been sent in. A brief examination of Figs. 11, 12 and 13 in that article will show that the velocity of rotation for a given amplitude of motion of the stock (provided the spindle has a given diameter) will be twice that attained by the device of Mr. Cowley shown in the same article. I name Mr. Cowley's solution because it is a type of numerous solutions that I have in hand.

If the reader will refer to the previous article and scrutinize Fig. 11 therein, he will see that the device of Mr. Wright comprises a system of fixed and movable pulleys, C C' being the fixed pulleys, and B B' the movable ones. The movement of the stock one inch, therefore, causes a passage of two inches in length of the cord over the spindle, whereas, in Mr. Cowley's arrangement, and all others like it, or analogous to it, an inch movement of rotation of the periphery of the spindle corresponds with an inch movement of the stock. This seems to have been a feature that (though the advantage in securing a higher velocity with a belt movement is obvious) has escaped the observation of nearly all who attempted belt solutions, including myself. It therefore merits a commendation that I should have been glad to accord to it in the former article had I not then overlooked the effect of the ingenious arrangement of the pulleys now pointed out.

(*To be Concluded.*)

Tangent Circles.

By Frederic R. Honey.

The problem *to draw a circle tangent to three given circles* is given as an exercise in modern geometry.

It may be solved also by determining the intersections of the loci of the centers of circles tangent to the circles taken in pairs.

Thus, calling the three given circles, A, B and C, if we find the loci of the centers of circles tangent to A and B, and then the loci of the centers of circles tangent to A and C, the intersection of these loci will determine the centers of the required circles.

An infinite number of circles may be drawn tangent to two given circles.

The most obvious and simple examples are illustrated in Fig. 1, in which A and B are the given circles. The centers of the four tangent circles C, D, E, and F are in the line of centers of A and B, and their diameters are readily determined by an inspection of the figure. As in Fig. 1 there are, in general, four ways in which a circle may be drawn tangent to two circles. They are C, D, E and F, illustrated in Figs. 2 and 3, A and B being the given circles in each case.

The locus of the center of a circle tangent to two given circles is an hyperbola.

1st. To prove this let o'', Fig. 2, be the center of a circle C tangent to A and B, whose centers are respectively o and o'.

Since $o''\ a = o''\ b$, the difference between the distances $o''\ o$ and $o''\ o'$ is the difference between r and R, the radii of the given circles; and this is true for every circle which is tangent to A and B drawn in this way.

The locus of o'' is therefore that of a point, the difference of whose distances from two fixed points o and o' is constant and equal to $R - r$. This conforms to the definition of an hyperbola.

Also let o''' be the center of a circle D tangent to A and B.

Since $o'''\ c = o'''\ d$, the difference between the distances $o'''\ o$ and $o'''\ c'$ is also the difference between r and R; and this is true for every circle which is tangent to A and B drawn in this way. Therefore the locus of o''' is that of a point the difference of whose distances from two fixed points o and o' is equal to $R - r$.

The loci of o'' and o''' are therefore the two branches of the same hyperbola. This curve is represented at a a', Fig. 4.

2d. Let o'', Fig. 3, be the center of a circle E tangent to A and B.

Since $o''\ a = o''\ b$, $o''\ o = o''\ a - r$, and $o''\ o' = o''\ b + R$, the difference between $o''\ o$ and $o''\ o'$ is equal to $r + R$.

Therefore the locus of o'' is an hyperbola, the difference of the lengths of the focal radii being equal to the sum of the radii of the circles A and B.

Also let o''' be the center of a circle F tangent to A and B. Since $o'''\ c = o'''\ d$, $o'''\ o = o'''\ c + r$, and $o'''\ o' = o'''\ d - R$, the difference between $o'''\ o$ and $o'''\ o'$ is equal to $r + R$, and the locus of o'' is the other branch of the same hyperbola which is the locus of o''. This curve is represented at b b', Fig. 4. In Fig. 5 the hyperbolas which are the loci of the centers of circles tangent to A and B are drawn; the loci of those of A and B, and of B and C. The intersections of these curves determine the centers a, b, c, d, e, f and g of seven of the tangent circles. The eighth intersection falls beyond the limits of the figure.

In order to avoid confusion of lines the eight tangent circles are represented in another drawing, Fig. 6.

It will be observed in Fig. 5 that six hyperbolas are drawn, while only four are needed in order to find the centers.

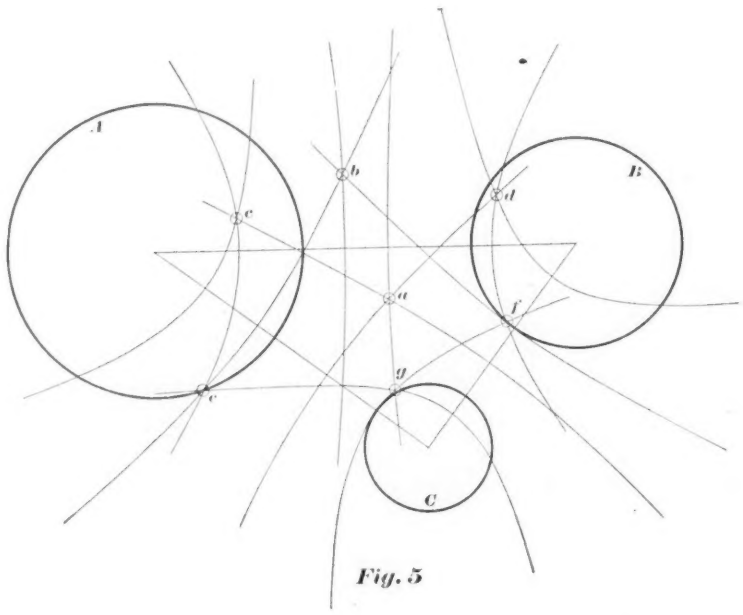


Fig. 5

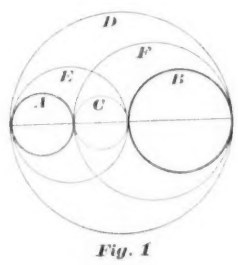


Fig. 1

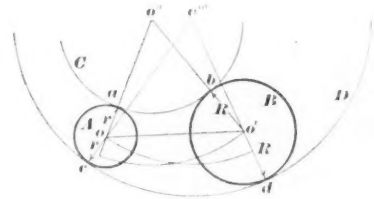


Fig. 2

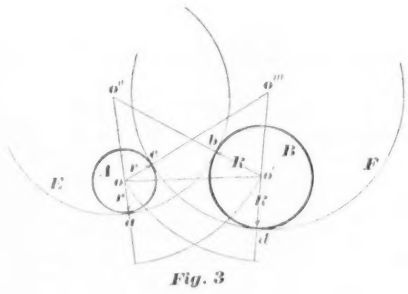


Fig. 3

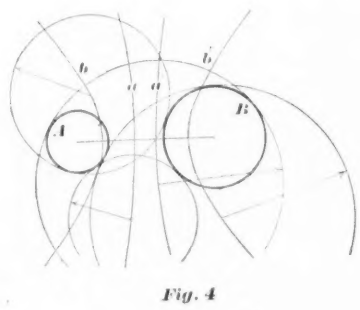


Fig. 4

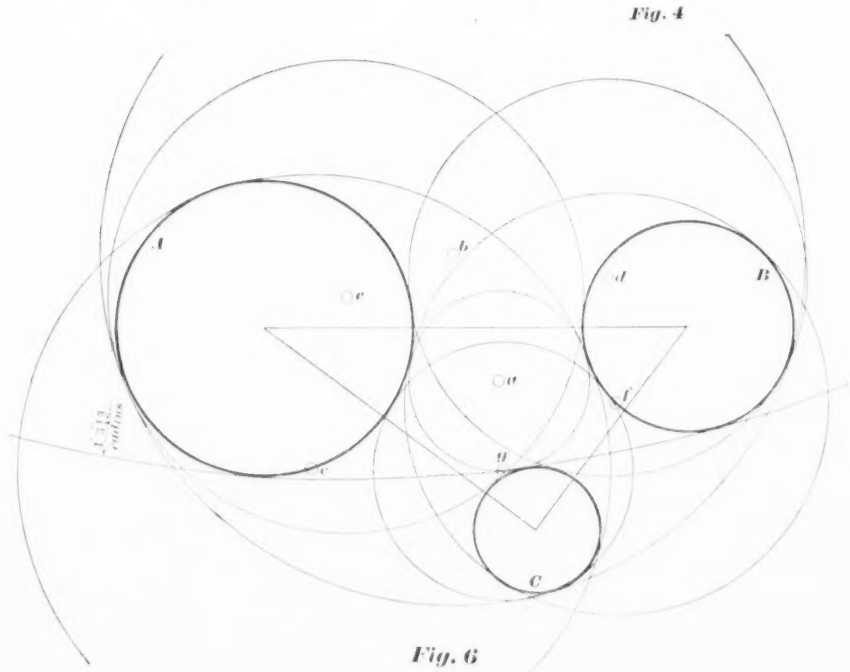


Fig. 6

Tangent Circles.

Commercial Training for the Engineer.

London *Engineering*, in an editorial article on "The Commercial Aspect of an Engineer's Training," points out the fact that —speaking, of course, of British practice— one of the most important elements appears never to be taken into account—that is, the commercial element. Our contemporary reasons that while a young engineer as now trained, that is, with the usual apprenticeship and a technical course of study, may become proficient, by practice, as a draftsman, and with his knowledge gained in the work shop and drawing office may be able to design and represent by drawings mechanism for a given purpose that will be efficient and economical in construction, but that when he aspires to the position of manager he finds himself distanced by some one understanding the commercial part of the business, but who is below him in his abilities as an engineer. The writer concludes:

For obvious reasons it is very improbable that any further facilities for acquiring such information [commercial knowledge] will ever be afforded to apprentices by their employers, but that is no reason why this want should be allowed to continue. Every industrial center of any importance has now got its own technical school, and each appears to rival its neighbors in the comprehensiveness of its syllabus. Why should there not be given, in addition to the usual subjects, a course of instruction in prime costing and other commercial knowledge requisite in the management of an engineering works? Against this suggestion it may be argued that inasmuch as each works has a system peculiar to its own requirements, and that no system of universal application can be formulated, the subject is therefore an unsuitable one for a technical school. While fully admitting that the system adopted in any works must, as a matter of convenience in practice, have many of its details shaped by such considerations as the size of works, and nature of work turned out, it must be remembered that these differences are only in details, while the system as a whole is as universal in its application as that of workshop practice itself. It is not assumed that a good business man can be evolved by any system of technical instruction, any more than a good engineer can, unless there is a natural aptitude for the work; but it is suggested that a course of commercial instruction cannot fail to assist in the development of that business capacity so essential to the success of most engineers. Which of our technical colleges will be the first to give this matter the attention it undoubtedly deserves?

Columbian Exposition Notes.

CRANES.

The Pittsburgh Bridge Company has begun the erection of the runways for two traveling cranes in the Machinery Hall. These cranes will command blocks known as No. 3 and No. 5 of the power plant occupied by the six Westinghouse 1,000 horse-power direct-connected engines and dynamos. Block 3 has 2 and block 5 has 4 of the machines.

The big Sellers crane covers a very small portion of the blocks, and these cranes run at right angles to the big one, and extend from it to the end of the block, thus covering the remaining area.

These cranes are of 25 tons capacity and have a travel of some 60 feet. That for block 3 is of 20 feet span and for block 5 of 30 feet span. The runways are made of continuous plate girders, extending the entire length, each supported upon 4 latticed, channel ports.

The cranes themselves are to be furnished by the Yale & Towne Company. They will be operated by hand and have two trolleys each; much the heaviest loads that either crane will handle are the great armatures, each of which weighs 22½ tons.

GENERAL NOTES.

The Westinghouse Company have a great deal of material on the floor, and the heavy base castings and uprights for several of their big dynamos are now in place.

Work is begun on the erection of the 2,000 horse-power Allis engine. The receivers and one cylinder were put in place the latter part of last week. The 500 horse-power Allis is all ready for the pistons and crank-shaft.

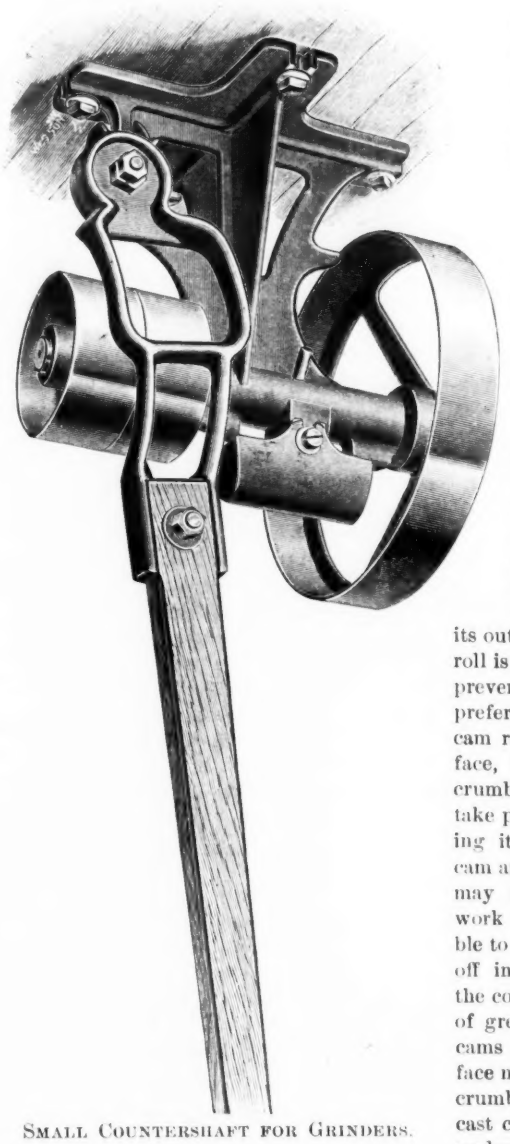
The first engine of the permanent power plant to be used was started last week. It is one of the two 400 horse-power Westinghouse, and it is running an incandescent dynamo for lighting some of the offices on the grounds.

There has been received recently at the Government Building a very large cannon. It is known as a 12-inch breech-loading sea-coast rifle. It weighs 116,000 pounds and fires a shot weighing 1,000 pounds with a powder charge of 460 pounds. The gun was built at the Watervliet Arsenal, West Troy, N. Y.

A specially constructed car was used in bringing it here. This car was not built for carrying this particular gun, but for one of the big Krupp guns which are expected in Chicago from Essen, Germany, in three or four weeks. The car is built almost entirely of iron and steel and has four trucks, coupled as follows: Each pair of trucks are spanned by plate girders, thus making in reality two larger trucks; connecting the centers of these were other longer and stronger girders which carried the guns.

Small Countershaft for Grinders.

The accompanying illustration is of a recently designed countershaft, made especially for use with small grinders, and made by the Norton Emery Wheel Co., Worcester, Mass.



SMALL COUNTERSHAFT FOR GRINDERS.

It will be seen that the hanger consists of a single casting, having a solid bearing for the shaft, and so provided with oiling devices that all oiling, including the countershaft, is done at the central oil hole, and all waste oil is caught and retained in the drip cup. The large driving pulley is so formed that the belt pull comes entirely within the bearing. The form of belt shipper adopted makes it entirely self-contained, does away with rods, fingers, etc., and avoids all things that are liable to get loose and rattle. It also makes it a very simple matter to attach the handle. The tight and loose pulleys are 5″ diameter, 2½″ face; driving pulley, 1¾″ x 2½″; diameter of shaft, 1″; weight, 45 pounds. The pulleys are accurately balanced, and the shaft can be run at a very high speed, if desired.

LETTERS FROM PRACTICAL MEN.

Breaking of Parallel and Connecting Rods of Locomotives.

Editor American Machinist:

Circumstances have arisen in railroading in this part of the country to attract my attention, and I haven't a doubt but will be food for thought and theory by yourself and your readers.

Recently a serious accident occurred near Moscow, Pa., on the D., L. & W. R. R., by the breaking of a side rod strap of the engine to train No. 3 coming west.

The engineer and fireman are badly hurt, principally by scalding water and steam; another employe of the road who was sitting with the fireman in the cab was badly hurt also.

The particulars of this accident you will doubtless get from the daily papers; but what prompts this letter to you is that the day before another accident of the same character occurred on the O. S. & Binghamton branch of the D., L. & W. R. R., near Messengerville, in which the connecting rod straps on both sides of the engine broke, but fortunately did not rupture the boiler or seriously hurt any one.

Now comes a singular coincident of this last accident. Less than a month ago another engine broke a connecting rod within a few feet of where this last-mentioned accident occurred.

I say breaking of connecting rods, but I must explain that I cannot now say whether it was the connecting rod or parallel rod that broke, but whichever it be, the frequent breakages of this part of the engine on one of our trunk lines furnishes food for serious reflection and investigation

"TRAVELER."

Cam Rolls.

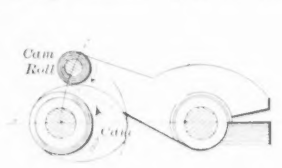
Editor American Machinist:

I have read the conical cam roll discussion with interest, expecting things which have not been said so far, and now I am going to say some of those unsaid things myself. I am building machines with plenty of cams in them all the time; I think I get as much and as good service out of cams as any one does, and yet I am not very certain about some things connected with cams, nor very well suited with anything belonging to them.

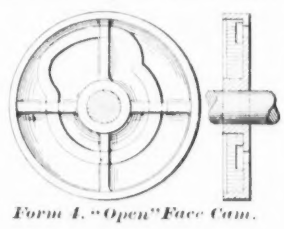
There can be no dispute over cam rolls among those who use them, any more than over cams; all cams are monstrosities and nuisances, and with some forms of cams the roll is the first part of the machinery to show wear, and this wear is in some instances so persistent through all expedients for its removal, as to make the cam roll question seem very important and very difficult of solution. From my point of view there are few questions about cam rolls, so few that I can sum up the essentials of cam rolls in one sentence as follows: A cam roll should always be either a cylinder or a barrel-shaped roll, with square ends and a straight hole, made either of gray iron or hardened steel on the face; if made of gray iron it should be a careful lathe job without eccentricity; if made with a hard face it should be ground true inside and out before being put to work.

Probably one reason for the diverse opinions in regard to shapes of cam rolls given of late in these columns is to be found in the fact not noted hitherto, that there are at least five different forms of cams to which rolls may be applied, each of which different forms gives a different effect on the roll.

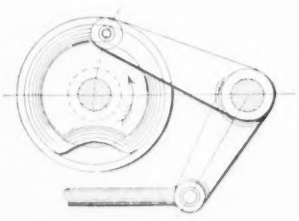
In the edge cam, form 1, the cam roll is placed over the cam generally and held down in contact by gravity. This is the form of cam roll referred to by C. O. Sine recently. Obviously this cam roll does not need to be conical. The only change from the cylinder advisable is the rounding of its outer corners where the length of the cam roll is less than the width of the cam face to prevent crumbling of the roll corners. I prefer in all cases to make the length of the cam roll greater than the width of the cam face, because I believe this to cause all crumbling and flaking of outside edges to take place on the cam roll, the cam retaining its edges much better than when the cam and roll have faces of even width. I may say in explanation that under heavy work cast-iron cams and cam rolls are liable to crumble at the edges, or even flake off in pieces of considerable size, owing to the constant upsetting of the metal at points of great strain, and I have frequently seen cams as much as 48″ to 72″ diameter by 8″ face made of steel castings to obviate this crumbling; as might be expected, however, cast cast-steel does not wear well in cams under heavy work, its resistance to crushing being less than that of close cast-iron, which is, in my opinion, the most suitable material for either light or heavy cams; points subject to extreme wear may in some cases be fitted with hardened steel faces, which require great care in location to make the remedy better than the disease.



Form 1. "Edge" Cam.



Form 4. "Open" Face Cam.



Form 2 "Face" Cam

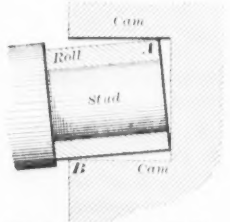
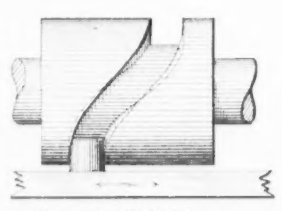


Fig. 5. Misplaced Roll.



Form 3. "Side" Cam.

Fig. 6. Barrel Roll.

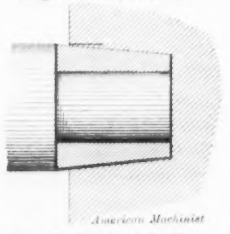


Fig 7. Conical Roll.

Form 2 is the face cam very much used in light machinery. It is not a good form of cam, and late practice tends to the edge cam in its place, although analysis shows that the face cam really consists of an internal and external edge cam; but these two edge cams are connected by a vertical web, which makes the cam groove "blind" or closed on one side. The cam roll used is supposed to be cylindrical, but is commonly, so far as my experience goes, smaller at the inside edge than at the outside after wear, and the same is true of the cam rolls which have worked in form 3, the side cam.

The side cam is the worst of all cam forms. It is largely used still for light work or for slow heavy work. I can point to large establishments, notably the Hartford Screw Company's shops, whose work is almost wholly performed on these side cams. The old Howe sewing machine used cams of this kind, and so I think did many others of the old machines. It is this cam which has been said to require conical rolls. The truth about the conical roll is, as stated by Mr. Robinson, that no conical roll can ever exactly fill the groove of a "cylindrical" or "side" cam, as I have called it; this is obvious to any one who will follow the action of the cam groove in his mind; I was greatly surprised when Mr. Pentz assumed that a conical roll should fill such a groove, and I am still more surprised that Oberlin Smith, who designed for the Standard Oil Company one of the most ingenious cams that ever came under my notice, should seemingly fall into the same error in the AMERICAN MACHINIST of March 2. It will be noticed, however, that Oberlin Smith is unable to fix the angle for the cone, and it seems strange that he should have signed his name to an article which leaves the reader in doubt as to whether he ever used the conical cam roll or not. Another odd thing is that Oberlin Smith should point out the fact that the groove in the side cam at one extreme, where the groove is parallel to the axis of cam revolution, demands a cylindrical roll, while the groove at the other extreme standing at right angles to the cam axis may take a conical roll, and should still in the face of this absolute contradiction of extreme conditions assume the possibility of some cone which should satisfy varying conditions intermediate between those two extremes, while it is clearly evident that every change of angle of cam groove demands a change in the roll shape if a radial line contact is to be had.

In point of fact even if the conical cam roll gave a perfect theoretical rolling contact there would be no working gain, except in cases where the stress would crush a cylindrical roll in a rectangular groove doing the same work, and I have never seen a cam of this form used for severe labor. It is true that cam rolls in cylindrical or side cams are often ragged and pitted and look as if crushed, but this appearance comes from upsetting and crumbling through repeated blows, not from a crushing pressure; the correct remedy indicated by such conditions of cam roll wear is not an increased surface of cam roll contact; the unfavorable wear is caused not by more pressure than the surface can sustain, but by a constant series of blows, which distort the surface of the metal and lead to surface disintegration. Hence, what is required is lighter parts, a finer graduation of the cam at points of change of motion, lighter cam rolls, less hammer and anvil effect, making the cam larger, the roll smaller, the roll face less, and the roll lever longer, and especially, as previously said, giving more time to the change in direction of motion.

The merits of the barrel-shaped cam are made clear by sketches 5 and 6. Inspection shows that with a cam groove and misplaced roll, as shown in Fig. 5, the roll must crumble at *A*, and the cam groove edge at *B*, as those are the points least supported against the stress in the material set up by the upsetting action of the work.

Inspection of Fig. 6 makes it very clear that the metal of both roll and cam is placed in the most favorable position to resist destruction by upsetting the metal.

The taper cam roll shown in Fig. 7 does not help anything to prevent wear, but has all the working faults of the cylindrical roll, the whole work of the cam being thrown from one unsupported edge of metal to the other until a barrel shape results from wear or the roll stops turning.

It is not surprising that a good machinist should fit a face cam groove with a tapering cam roll without finding out that the roll did not fit the cam groove at all points, because the roll cannot fit the groove at any point, since the roll must be so free in the groove as to revolve, having contact on one side only of the roll, and there is, consequently, always a very decided slack in the fit of the roll in forms 2 and 3. The great point to gain to secure durability in cam rolls is the revolving of the roll on the roll-pin as the cam works. In the edge cam, form 1, the roller always runs in one direction, and is never still so long as the cam revolves; on the contrary, in the face and side cams in forms 2 and 3, the roll turns part of the time one way and part of the time the other way, if it runs at all, which it very often does not, and in consequence must be free in the groove to fill its office. It is impossible to see with the eye whether the conical cam roll touches its whole length or not in the cam groove, and I have no doubt the advocates of the conical roll honestly believe that the contact between roll and groove side is perfect.

What is wanted of a cam roll, first of all, is revolution; the roll should turn; if it does not turn a flat is at once formed, a large flat, often, on the side of the stationary roll, and that roll will never turn again. This turning of the cam roll can never be certainly secured with any form of smooth cam and roll except form 1, the edge cam, and one other form which I have not shown; in that form the roll runs one way only, and can have a certain contact with the cam.

The cam roll for the grooved face cam can be made to revolve with great certainty by making the cam large, the roll small and thin, and by doing away with the blind or covered groove, so that the roller can be longer than the operative face width of the cam.

This is done by the open-face cam shown in form 4. The internal and external edge cams forming the open-face cams are connected by arms, cored out where they pass the groove, so that the working cam faces are clear, and not connected by a web. One of the most beautiful machines I know of in action is operated by these cams at high speed, and I am told that the cams are very satisfactory. The cams are 12″ outside diameter, and the cam rolls are $\frac{3}{4}$″ diameter; the cam face is $\frac{5}{16}$″.

I myself am not quite certain about the cause of the sticking of cam rolls in forms 2 and 3. I do not use these forms of cam; I think the trouble is, first, that the grooves are cut wider at the outside than at the bottom; if such is the case this would cause the reversing impulse to be applied at the extreme inner corner of the cam roll, and thus might easily lead to the formation of small flats on the inside end; I know, however, that the narrower the roll face is the more likely the roll is to work well, and that rolls which would never run if made straight-faced often do run when crowned a little; therefore if I were to use a cam of that vile sort in which the roll had to change its direction of rotation one or more times in each revolution of the cam, I should use with it a cam roll slightly crowned on the face and bearing only on a very small part of the mid-surface of the cam groove wall, feeling certain that in this case, as in many others, the right was also the

Easy Way.

Mr. Grant's Treatise on Gears—Conical Cam Rollers.

Editor American Machinist:

In your issue, February 23d, I notice under "Literary Notes" a notice of George B. Grant's "Treatise on Gears."

Having used his "Hand-book on the Teeth of Gears," second edition, for more than four years for his chart for shaping bevel-gear blanks (to save laying out full size), and always without trouble, had occasion the other day to use a copy of his "Odontics, or the Theory and Practice of the Teeth of Gears," copyright 1891.

I found that in the bevel-gear chart, page 90, for shafts at 90 degrees, the center angles of the two gears added do not make 90 degrees. Also that in comparing 1887 and 1891 editions the angle increments, as also the diameter increments, are not the same for the same proportioned gears.

I have always and do yet look upon Mr. Grant as being the leading authority on cut gear teeth in the country, and would therefore be pleased to have above variance explained or corrected by the author; for with all due respect to Mr. Grant's vastly superior knowledge of gears, and without calculating for myself the increments, I believe the chart of 1891 to be faulty in some respects in which that of 1887 was correct. For with me the center angles added equal the angle of the shafts. Of course, the center angles being stated differently in the two editions, the angle increments would of consequence require to be different, as they are; but not so the diameter increments. A preface to the 1891 edition, stating the ressons for the change, it seems, would have been in order. Would like to hear Mr. Grant's reasons, *pro* and *con*, concerning his method of making the bottom clearance a tapered one of $\frac{1}{6}$ of the angle of the addendum.

One reason for it would appear to be that of making the clearance at each end of the tooth proportional to the size of the tooth, as is done in different pitches of spur gearing; one reason against it would appear to be that inaccuracies in setting, etc., would misplace the whole wheel; not one end of the tooth more than the other, and therefore call for parallel clearance, such a clearance as would be obtained by cutting clearance $\frac{1}{6}$ of addendum deep at big end of tooth, and to an angle obtained by subtracting from center angle a decrement equal to the increment used for the addendum of the mating gear. The Pratt & Whitney Co. cut their bevel gears with the parallel clearance, I believe.

Adding to what has been said about the conical rolls in practice will say that the writer examined critically, a few days ago, for the purpose of seeing just how well it had lasted, a conical roll upon a Potter-Scott web rotary printing machine that had been running about eleven years, and while other parts of the machine showed quite some signs of wear, this roll and cam were in comparatively good shape, and, I believe, the machines are still made with the conical rolls.

C. J. Robertson.

[We have referred so much of the above as relates to gears to Mr. Grant, who answers as follows:—Ed.]

Editor American Machinist:

In reply to yours concerning errors and alleged errors in my "bevel gear chart":

Errors in Center Angles—Your correspondent is correct, but very late. The trouble, of no practical importance, was discovered by about a couple score of my readers, and it does not appear in the latest or sixth edition, the paper-covered edition of my "Treatise on Gears." I shall be pleased to send a correct copy of the chart to any owner of a copy of the cloth-covered book. I cannot imagine how it happened.

Errors in Increments—The increment is an approximation at best. If your correspondent will reduce his complaint to angular measurement in some practical case he will see what a fine hair he is trying to split.

Clearance—This is wholly a matter of opinion, and the various values of different writers are each correct. I adopted one-sixth of the addendum because that is a handy number to use and as good as any.

Parallel Clearance—This wrinkle is neither pretty or practical and I want nothing to do with it.

Taffy—I am grateful for the elevated opinion of myself as a gearist expressed by your correspondent. There, at least, he may be correct, but my ability has not yet reached such a height that I can write a book on gears that shall suit all the various and miscellaneous critics that are likely to assail it, nor one that shall be typographically correct from cover to cover.

George B. Grant.

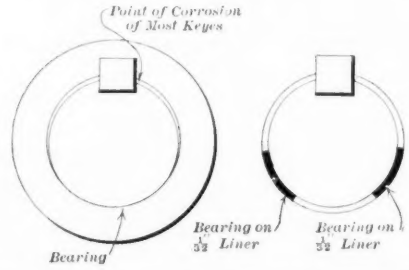
Lexington, Mass.

About Keys.

Editor American Machinist:

The article on keys in your paper is a good thing. I say, by all means let us have standard sizes and tapers for keys made by some firm used to getting out accurate work; we could have some of them got out in lengths up to 24 inches or more and cut them where wanted, with a reasonable certainty of a fit.

In my practice I have never found a key that was corroded and stuck that upon examination of same I did not find had been a poor fit when it was put in. I fail to see how any of the various tapers $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ inch to the foot would help matters in such cases. We have here very heavy work out of doors in all kinds of weather, in sea water, and sometimes out drying in the sun, sand, shell and mud to contend with, and I have keys in use of all three of the tapers, and must say for my part I like as little over the $\frac{1}{8}$ inch in 12 as the circumstances will allow of. It is obvious the greater the taper the harder the key will have to be driven to make it hold, and the first $\frac{1}{32}$ of an inch the key is to be backed out will take the equivalent of the last blow that sent it home. A key properly fitted and a little tallow or any



thick oil put on it before driving cannot corrode, and a proper short stiff drift that sets nice and square to end of key, and has nearly the same sectional area as end of key (and same shape) held with a tongs, and the first blow strong and sure, and the key will start; after this can use long drift.

I know this last is not news to the majority of your readers, but how often have they, as well as myself, seen more damage done in one careless minute on the end of a key than would take a day to get around by drilling or breaking out.

Let us have, say, $\frac{3}{16}$ inch taper in 12 inches, $\frac{1}{4}$ diameter of shaft for width, and, say, $\frac{1}{6}$ diameter of shaft for thickness at small end.

I inclose a sketch of way a pulley will hold better a sixteenth loose for shaft and one key, than it will the ordinary sliding fit and one key. I have tried it several times, sometimes by cutting out the spaces in pulley or pinion, and sometimes by use of liners, as shown; you will see in the ordinary sliding fit of pulleys and shafting and one key there are but two points of bearing the key and diametrically opposite, where in the other there are three, and the key tends to force shaft in between the two opposite points.

C. W. Jewell.

Annealing Mushet Steel.

Editor American Machinist:

As to the article on Annealing Mushet Steel, I would say I have used it very successfully in the making of forming cutters, and also facing cutters. And I would suggest that information as to the working of such steel can be gotten through B. M. Jones & Co., 10 Oliver street, Boston, where I got mine. I used to anneal it in wood ashes in sealed pots in the furnace, not taking out till cold, when I worked it as ordinary tool steel, though some harder, and hardened in oil at a very low heat. The hardening process is probably where a great many fail, as annealing takes some of the life out, consequently the air harden does not prove satisfactory. I discovered this by accident. In trying to harden a piece in the air I could not get it hard enough to suit me, and in heating it again, I dropped it in the oil, and, to my surprise, it was just what I wanted. I could continually grind and grind without drawing the temper.

A Reader.

Is Wet Fuel Economical?—Good Firemen—Patent Agents.

Editor American Machinist:

In reply to Mr. Crane's question I would say that what I wrote about moisture was not intended as a laying down of a law, but simply to call attention to a paper which seemed of considerable interest. My own impression always has been against wet fuel, for it has always seemed to me that any water evaporated in the furnace must be done at the expense of evaporation in the boiler. Still, as I understand it, the advocation of more moisture than that naturally formed by the combustion of the hydrogen of the coal does not include such an amount as is represented by ordinarily wet coal, but just a little in the form of steam, and, too, dry steam. There may also be very numerous cases where the improvement of a fire due to wet coal may be such that an overworked fireman is enabled to keep his fires in much better order, and thereby economy may be secured indirectly, and though we may not be able to find the cause, one fireman may find moisture useful, and another man may not. So very much depends on the fireman, that it is essential he be a man of intelligence, and a good fireman is always more than worth his pay. In a case which came under my notice, a fireman attended to five 7 feet by 28 feet double furnace boilers in a large cotton mill. He not only did all the firing, but he wheeled all the ashes to dump, and it is hardly necessary to say that he burned a minimum of fuel, seeing that he never could have kept the engines supplied with steam had he not been very competent. One day he ventured to ask for more pay, and he was actually refused it, and he very soon obtained another place, and the work he had been doing has never since been done by less than two men, whose united pay is much more than the increased pay asked by the first-rate man. This was decidedly a false economy, for the two men do no more than the one man did. They earn their pay, for they throw more coal into the fire, but the engine only runs at the same old speed and turns the same old load.

The value of moisture seems to come in with regard to the ash and clinker. The figures given by Mr. Crane show a less percentage of ash with the wetted coal. There are so many men who are interested in coal-saving appliances, real or pretended, that truthful figures are not easy to obtain, nor is it safe to take any proved device in one instance as equally good for general application.

In reference to the "Inventor Trap" of P. A. M., if he will send me the address of the people, I will ascertain, if possible, if such people exist beyond having a postal address. Probably they will refund the fee with about the readiness of a shady broker, but it would be useful to publish their names in the American Machinist. It is quite common among a certain class of patent agents to send circulars to all those whose applications give evidence of being home made. These circulars draw attention to the departures made by the applicant from the usual lines, and the fearful consequences which will follow any failure to employ the senders of the circular. They promise to carry through for so much, and, I suppose, make about 10 or 15 dollars on each "provisional," for which the applicant has the "benefit of our wide and varied experience," etc.—all a fraud. And yet inventors are themselves largely to blame; they are so self-willed in their own conceit, and take offense at the slightest hint of faulty mechanism, and fall readily into the maws of the fraudulent agents, who don't know enough to discover faults, and would not point them out if they did. I well remember when I

used to examine inventions for an agent who was not much of an engineer, that I mortally offended a man who had a cut-off to patent. It certainly did regulate the power of the engine, but it did so by always cutting off at the same point and varying—the point of admission. The cylinder was filled earlier or later, but it was filled at boiler pressure every stroke, and the cut off had no effect on steam consumption whatever. As matters now stand, any worthless thing can be patented, and a patentee with a long purse can prevent the use of an article or process which is not really original. On the other hand, an honest patentee, with a good patent, can be robbed with impunity by any rich man.

It is told me that the owners of a patent for a certain machine deliberately ruined every competitor in the same line by expensive and protracted litigation, irrespective of whether there was even infringement, but they left one firm severely alone, because they learned that this firm were ready for them, and had put aside about £100,000 for fighting with. I think a patent should only be granted to inventions properly determined as sufficiently good by a proper authority, that any infringement notified to such authority should be dealt with by them conclusively without expense, except a moderate fee to the loser, and that no lawyers should be permitted to intervene. Our courts at present are chiefly occupied with patent cases or society frivolities, and the very term scientific witness is a reproach.

W. H. BOOTH.

About Emery and Cement for Emery.

Editor American Machinist:

I saw in your issue of March 2d, 1893, that Mr. W. H. Booth wants to know about emery. I once worked in a factory where they used great quantities of emery and were prepared to grind and wash it themselves. They produce none for sale, never adulterate and never calcined it. This company bought the emery stone in Turkey. It comes in large boulders 6″, 8″ and 10″ in diameter, and sometimes larger.

These are broken with a sledge into pieces 2″ or 3″ in diameter, then ground in a mill that has a large circular iron pan with two heavy chilled iron rollers, such as is used for grinding fire clay and a great many other substances of like nature. It is then washed with water through a number of pans that separate the different grades. It was used directly as it came from these pans.

As to the cement he asks for, silicate of soda will answer his purpose. In fact some of the emery wheel factories use it for making their wheels. There is one make of wheels that I am acquainted with that are made of silicate of soda, which are excellent. The emery is mixed with silicate of soda until it is plastic, then pressed into molds of the required shape, removed and burned. I cannot tell him how hard to burn it nor can I tell what grade of silicate of soda (as there are many grades) to use. I have made several small articles of emery for experimental use that answered the purpose very well. I burned, or rather baked, them in a core oven. The silicate manufacturers will send the proper grade by knowing the purpose for which it is to be used. As to the magnetic qualities I have no knowledge except that the native stone is non-magnetic.

If Mr. Booth will communicate with me I will give him the address of the silicate manufacturers. If he wishes I will send him a sample of native emery. I can also send him some silicate of soda if he so desires.

He is welcome to any information that I can give him on this subject. I do this in return for many points received from him.

Anderson, Ind. HUGH HILL.

A Suggestion for Determining Clearance in Steam Engine Cylinders.

Editor American Machinist:

Having recently seen two 100 horse-power tandem engines wrecked by water and too small clearance at one end of cylinder by excessive shortening of connecting rod in taking up wear on crosshead and pin boxes, I would suggest the following as a means of easily measuring the distance from piston to cylinder head, so that the same clearance may always be had at the two ends of the stroke: Tap or have maker tap small hole in corresponding positions in the two cylinder heads (sometimes indicator holes will do), then by throwing engine on front and back centers, and knowing or measuring thickness of heads, we can get end clearance. Ordinarily the holes are closed by small plugs. Of course, the clearance can be got in the usual way with water, or by taking the cylinder heads off, but the first is not suited to the average engine runner, and the last is troublesome, especially with tandem engines. With some means of adjusting length of connecting rod, as double gib and cotter on crosshead, and a simple means of ascertaining the end clearances as I suggest, there should be no excuse for any runner of average intelligence allowing his end clearances becoming unequal. R. B. OWENS.

"A Leetle too Tight."

Editor American Machinist:

A recent article with the above heading calls to mind some experiences on a western railroad during the winter of 1873. The writer, while little more than a boy, had charge of the pit work in the shops, and, as is customary, was called on occasionally to do light overhauling in the roundhouse, the regular roundhouse man, "Tom," often being sadly overtaxed, both mentally and physically. "Tom" was a thinker, and a deep thinker at that, his peculiarity, however, being that he first did a thing "harum scarum," and then at the last moment, with the engine under steam, all would be discovered wrong; then he would get in his heavy work—mentally. The writer was passing through the roundhouse one day when he was hailed by "Tom"; he had been overhauling the valve gear of an engine, and the writer's opinion was desired whether all was right or not. An examination showed at once that the eccentric straps were "a leetle too tight," and with the remark that the engine would not go with things in that condition, "Tom" was left to his meditations. The following morning, being called to the general office, learned that the engine had broken an eccentric rod, with the natural result of knocking a hole through the fire-box, "killing" the engine on the spot. As motive power was badly needed, it was a serious matter, and the officials were very anxious to know the cause of this and many other mishaps of a similar nature, but the whole mystery was cleared up by the simple remark, 'just a leetle too tight."

As soon as the engine was towed in, "Tom" was promptly on hand to repair damages; the eccentric, which was a solid one, was burst through at thinnest point. "Tom" fixed it by bolting a curved strap on each side. When all was ready, the writer was called on to set the valves, and was somewhat surprised to find it almost impossible to move the lever. The rod was disconnected from the link, which at once sprung out of line about ¾ of an inch, and when the engine was moved ½ a turn, the rod took a similar position on the opposite side of the link, showing at once the eccentric was all out of true, and practically useless, and much valuable time wasted. A powerful striker from the blacksmith shop with a 20-pound sledge soon destroyed the source of trouble, a new eccentric made in halves was soon put in place, and the engine put to service. Shortly afterward "Tom" engaged elsewhere, in order that he might have "plenty of room for scope," and most of our troubles ended.

H. P. CLARKE.

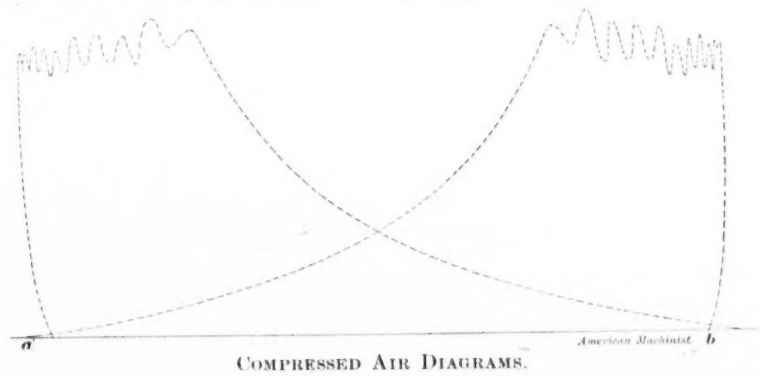
Washington, D. C.

The Cost and the Value of Compressed Air.

BY FRANK RICHARDS.

What is the actual power cost of a cubic foot of compressed air at any given pressure, and what is the power that can actually be realized from it? The question of practical economy is seldom as simple as this, and whether air shall be employed in a given case may be determined by other and very different considerations that still modify the question of ultimate economy and desirableness. Then there are many cases where at the present time the use of compressed air is imperative whatever its cost; but still as the bill has to be paid it is well to compute it. In considering the actual cost we will not now look into the possible economies of the case, but will try to get at the actual cost according to the common practice of air compression at the present time.

Say, then, that we have a steam actuated air compressor, with steam and air cylinders both 20″ diameter by 24″ stroke, at 75 revolutions per minute, using steam at 80 pounds and compressing air to 80 pounds. The case will then be like this:



COMPRESSED AIR DIAGRAMS.

Power required by air cylinder

$20^2 \times .7854 \times 36.6 \times 300 \div 33{,}000 = 104.53$;

$104.53 + 10$ per cent. $= 114.98$ H. P.

Volume of air supplied by air cylinder

$20^2 \times .7854 \times 300 \div 144 = 654.5$;

$654.5 - 10$ per cent. $= 589$;

589 cubic feet free air = 91.4 at 80 pounds.

Power of steam cylinder: steam 80 pounds, cut-off .25.

$20^2 \times .7854 \times 40.29 \times 300 \div 33{,}000 = 115.06$.

Volume of steam used

$20^2 \times .7854 \times 75 \div 144 = 163.62$;

$163.62 + 10$ per cent. $= 180$.

Here we find that a cubic foot of compressed air at 80 pounds costs just about two cubic feet of steam at the same pressure. It should be remembered that the same ratio will not necessarily hold for other pressures. For lower pressures the steam will have a little more advantage, and for higher pressure it will have a little less. The mean effective resistance assumed for the air cylinder is the theoretical resistance with no cooling of the air. In practice the actual resistance is somewhat less than this, but the difference between the air and the steam cards, or the friction loss of the machine, is also usually more than 10 per cent., so that few compressors in use will at their best give as good a result as the above.

The following little table gives the horse-power required to compress one cubic foot of free air per minute to a given pressure; also the horse-power required to furnish a cubic foot of air at the given pressure. The horse-power required is computed without regard to the motive power that may be employed or the economy with which it may be applied. It may be steam with or without cut-off or condensation, water-power, electricity, or anything else. When the quantity of air desired is known the approximate power required may be found by multiplying the number of feet required per minute by the power required for one foot, as here given. In the table the cubic foot of air represented after compression is assumed to have cooled to its original temperature whether cooled or not during the compression. It is not worth while to take account of the heat remaining in the air after it leaves the compressor because that heat is inevitably lost if, as usually occurs, any considerable interval of either time or distance intervenes before the air is used.

Table showing the horse-power required to compress one cubic foot of *free air* per minute to a given pressure with no cooling of the air during the compression; also the horse-power required, supposing the air to be maintained at constant temperature during the compression:

Gauge Pressure.	Air not Cooled.	Air constant Temperature.
100	.22183	.14578
90	.20896	.13954
80	.19521	.13251
70	.17989	.12606
60	.164	.11558
50	.14607	.10565
40	.12433	.093667
30	.10346	.079219
20	.076808	.061188
10	.044108	.036944
5	.024007	.020848

Table showing the horse-power required to deliver one cubic foot of air per minute at a given pressure with no cooling of the air during the compression; also the horse-power required, supposing the air to be maintained at constant temperature during the compression:

Gauge Pressure.	Air not Cooled.	Air constant Temperature.
100	1.7317	1.13801
90	1.4883	.99387
80	1.25779	.8538
70	1.03683	.72651
60	.83344	.58729
50	.64201	.465
40	.46271	.34859
30	.31456	.24086
20	.181279	.14441
10	.074106	.06 069
5	.032172	.027938

To one familiar with indicator cards from the steam cylinder and not familiar with those from the air cylinder the latter are at first a little confusing, from the fact that all the operations represented are reversed. The admission line of the steam cylinder is the delivery line of the air cylinder, the expansion line is the compression line, the exhaust the admission line, and the compression line becomes the re-expansion line.

An indicator card from the air cylinder shows very accurately the quantity of air compressed and delivered at each stroke. The point where the compression line rises from the atmosphere line is the point where the cylinder may be known to be full of air at atmospheric pressure. Whatever distance this may be from the beginning of the stroke is to be deducted from the total length of the stroke, and this represents the total volume in the cylinder at the beginning of the compression. At the other end of the stroke there must be a certain quantity of air not delivered on account of the clearance or remaining space not traversed by the piston. The air filling this clearance space re-expands as the piston returns, and where this re-expansion line meets the atmosphere line is the point where the volume of air actually delivered may be measured from. Thus in the right-hand card of the pair herewith the total air compressed and delivered is measured by the length of the line *a b* as compared with the total length of the card. This card shows that fully 95 per cent. of the theoretical capacity of the cylinder was actually delivered. It is not worth while to strain too hard to annihilate all the clearance at the end of the stroke. The clearance represents a loss of capacity only. The connections cannot always be kept exactly to the precise length required, and the clearance does not represent a loss of power, because the force required to compress the air is returned to the piston by its re-expansion. The presence of this air makes it proper to set the valve of the steam cylinder with less lead than would be advisable under other conditions.

The nearer the admission line of the air card coincides with the atmospheric line the less the power required for the return stroke of the piston. Whatever the admission line falls below the atmosphere line represents so much resistance to be overcome; but the line is of no interest as relating to the volume of air in the cylinder, except at the last moment of the stroke when it should come as nearly as possible to the atmosphere line. The true reporter of the volume of air in the cylinder for the compression stroke is the point of departure of the compression line.

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A New Decision.

The trouble which at this writing is going on between the Toledo, Ann Arbor & N. M. R. R. and its engineers has led to a decision by the U. S district judge that is attracting considerable attention and discussion. The case seems to be that engineers of another road had refused to handle cars from the T., A. A. & N. M. road, and had quit work rather than handle them. For this the judge held the engineers in $200 bonds for contempt, he having ordered Chief Arthur to withdraw his order requiring Brotherhood engineers to refuse to handle the cars of the boycotted road. To judge from the comments of prominent lawyers who have expressed opinions on this action of the court, it involves a new principle and one which, if sustained, will put the relations of railroad employes and the companies upon a somewhat different basis from that which they have heretofore been supposed to rest upon.

The judge, in explanation of his action, distinctly affirms that when railroad men propose to quit work, they must consider the convenience of the public who is interested in the operation of the road. And it would seem also, from his language, that where, by quitting work, great or irreparable damage may be done to the road or to its business, this must also be considered. He does not, of course, carry this so far as to say that men must remain permanently in employment undesirable to them, but, in effect, that the time and occasion of their quitting work must be chosen with reference to these considerations. For the present, Chief Arthur, of the Locomotive Engineers Brotherhood, is obeying, and announces that he will continue to strictly obey the orders of the court, but it is well understood that the matter will not be allowed to rest here without a further test. It is a significant thing that prominent socialists are hailing the decision with every manifestation of delight, professing to believe that it is a long step toward the final absorption and control of every form of enterprise by the government.

And it is manifestly true that this decision, if sustained, will lead to other decisions regulating the conditions under which men will be required to work on railroads, and there would seem to be no logical stopping place until the liberty and freedom of action now enjoyed by both officials and other employes of railroads is very much restricted.

One of the first questions that will occur to the practical man will be as to what value, if any, an engineer will be to a road when he wants to quit its employment, but is prevented by law. We all know that an engineer who wants to quit, but is afraid to, can very easily make it to the interest of the company to discharge him.

Experience Seems Necessary.

The average newspaper man always evidently thinks that every new motor which is tried for propelling street cars must necessarily upset some previously established laws, this belief being shown, however, in various ways. An exhibition of an ammonia motor was recently given in this city, and one of the questions asked the man who was managing it was, How quickly can you stop it? When he declared that he could stop it satisfactorily, and yet failed to do so, the inference evidently was that this was because it was an ammonia motor, whereas it was, of course, simply a question of the efficiency of the brake, without regard to what the motor might be. Nearly all the reporters for the great dailies of this city are educated men, and presumably have studied in college the laws of motion and of force. Such study ought to have enabled this reporter, for instance, to know that the distance within which a car can be stopped depends upon the weight, speed, and the retarding power of the brake, and has nothing whatever to do with whether ammonia, steam, compressed air, electricity, horses or mules may have imparted the motion. But the average educated man who has studied these matters in school seems not to get any clear idea of them, and when it comes to applying principles to every-day matters, seems usually to be much further astray than one who has had no opportunities for systematic study, but has, instead, had something to do with the handling of machinery. It seems to be only another illustration of the fact that study of scientific matters does very little good, and seems to give one very little really useful knowledge, unless it is accompanied by such practical experience as will impress upon the mind the truths learned.

Some Coal Combine Methods.

Some revelations as to the methods pursued by the coal monopoly have been made in Minnesota, where the legislature is moving against the combine, and in doing so has gotten hold of and made public some letters written by men representing the combine; these letters showing that retail dealers in coal doing business in the State were required to pay to some sort of an association $100 as a condition to doing business, and that any one who had the presumption to go into the business of selling coal without this preliminary, simply had his supply cut off. Wholesale dealers had to pay $1,000 under the same penalty. The combine has been making a big row about the letters, and claiming that it is outraged by their retention and publication. While we are not fully informed upon the matter, the presumption is that this money was not a direct payment for the privilege of doing business, but was rather put up as a security or bond for carrying on the business in accordance with the rules laid down by the combine. That is to say, this was to insure that people who burned coal did not get it below the price fixed upon by the combine, and in case any one cut prices then part or possibly all of his payment was to be forfeited. A very nice business this—one by which competition is entirely removed, and the monopolists have everything their own way. We suppose the men who engineer this credit themselves with having great "business ability," but most people would call it nothing more than rascality—the ability of the highway robber, without his courage.

It is said that the wires of the trolley car system in Boston interfered with the operations of the firemen who fought the fire in that city last week, which was so destructive. But how long ought it to take a fire department to cut down and remove the trolley wires in any street where there is a fire? The obstruction that any trolley wires interpose in the way of the firemen's work ought not to delay more than a few minutes any operations in fire extinguishing.—Jersey City *Evening Journal.*

Quite a scheme, to be sure. But the obtuse firemen may—unreasonably, of course—object to fooling around live trolley wires. A delay of no more than "a few minutes" is quite reasonable, too, but for the stubborn fact that a "few minutes" is quite likely all the time required for a fire to get beyond control; with these two exceptions the plan of the *Journal* is all right.

Engineering, of London, describes a new flying machine devised by Mr. Horatio Phillips, of Wealdstone, near Harrow. The description is not sufficiently full to give much of an idea of the construction of the machine, but the editorial opinion expressed on the matter is that the machine bids fair to do very much toward the solving of the problem of mechanical flight. Further trials of the machine and an account of the results are promised. The sustaining surface is formed in section much like the wing of an albatross, and the motive power is supplied by a compound engine and boiler. The kind of fuel used is not stated.

We feel constrained again to call attention to the standing notice on this page to the effect that no attention will be paid to anything that is written by correspondents who do not give us their names and addresses. We do not publish these names when requested not to do so, but we must in all cases have them at this office. We mention this particularly at this time, because so many unsigned communications have found their way to the waste-basket during the past six weeks. Good ink, good paper, and sometimes good ideas are wasted by the mere omission of a name and address.

At a dinner recently given in Brooklyn, at which the retiring and the new secretaries of the U. S. Navy were both present, ex-Secretary Tracy stated that when the ships now under construction were completed, our navy would rank fifth in power, being surpassed only by those of England, France, Russia and Italy. In making comparisons he stated that our vessels would be able to throw 31,000 pounds of metal in any given direction at a single discharge, while those of Germany could throw 25,000 pounds; and in other respects, such as speed and general efficiency, our vessels much surpassed those of Germany.

Aerial Navigation.

The "Preliminary Address of the World's Congress Committee on an International Conference on Aerial Navigation" has been issued and gives an outline of what it is proposed to do at the conference, which is to be held in the afternoons of August 1, 2 and 3, 1893.

Papers and discussion will be presented there under three divisions of the subject, viz.: 1. "Scientific Principles." 2. "Aviation." 3. "Ballooning." Full information may be obtained by addressing Prof. A. F. Zahm, secretary, Notre Dame, Indiana.

Mr. Herbert W. Harris, formerly of the *Electric World*, has bought from Egbert P. Watson a half interest in *The Engineer*, and will be identified in its management and publication.

Literary Notes.

DUTY AND CAPACITY TESTS OF WORTHINGTON HIGH-DUTY PUMPING ENGINES ON WATER-WORKS AND PIPE-LINE SERVICES, is the title of a neat volume recently issued by Henry R. Worthington, 86 and 88 Liberty street, and 145 Broadway, New York.

In this book reports of eighteen different pumping engines are given; a number of these have already appeared in pamphlet form or in current engineering magazines in this country and in England, but this is the first attempt to assemble them under one cover, and put them before engineers in more convenient form for reference. The illustrations are exceedingly fine, and these, in connection with the fund of information which the book contains relating to pumping engines in successful operation in this country and abroad, make it a very valuable one in the hands of engineers.

We have received a report of the duty trial of a fly-wheel, high-duty, automatic cut-off, cross-compound pumping engine, designed and built by the Geo. F. Blake Manufacturing Company, of New York, Boston, Philadelphia and Chicago.

This engine is located at Newton Upper Falls, and was built for the City Waterworks of Newton, Mass. The engine has an H. P. cylinder 21 inches diameter, and one L. P. cylinder 42 inches diameter, and both are provided with a Corliss automatic valve gear. There are two double acting inside plunger pumps, the diameter of the pump plungers is 13½ inches, and stroke of all pistons and plungers 40 inches. The requirements were that it should have sufficient capacity to deliver easily 5,000,000 U. S. gallons in 24 hours of continuous operation, into the reservoir, through a force main 3½ miles long and 20 inches diameter, against a maximum head, exclusive of friction in the pipes, of 235.25 feet.

The report, which is very favorable to the builders, is very complete and cannot fail to be interesting to engineers. For the benefit of those unfamiliar with the method of calculation of duty adopted in this test, the various steps required are given in an appendix, the ordinary methods of rating

duty are also given, so that comparison can readily be made. The report also contains fine illustrations of the pumping engine.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(139) G. F., Pittsburgh, Pa., asks: Can a pair of bevel wheels be made to work which are placed on the ends of shafts not at right angles to each other, as shown in sketch? *A.*—Yes.

(140) J. T., York, Penn., asks: How are short pipe nipples held and prevented from turning while being threaded? *A.*—There are chucks made for the purpose which tighten like pipe tongs, as the tendency of turning increases.

(141) F. E. P., East Taunton, Mass., writes: I would like to know if there is any way of calculating the capacity of an inspirator of any make. *A.*—The capacity can be computed, but the best and simplest way is to obtain a table of capacities from the makers of the inspirators.

(142) J. P. S., Alex., Va., asks: What is the diameter of a pop safety valve for a boiler with grate 33 inches diameter? One square inch is to be allowed for every three square feet of grate surface. There has been a dispute over this. I make the diameter 1.505 inches. *A.*—The correct answer is 1.587.

(143) A. R., Somerville, Mass., writes: Please inform me where I can obtain Bourne's catechism of the steam engine and A. Jamieson's text book on the steam engine. *A.*—You can obtain these from any dealer in scientific works; the addresses of some of these are given in our advertising columns.

(144) D. B., Bakersfield, Cal., writes: Please inform me how to blue gun barrels. *A.*—Apply nitric acid, and allow it to eat into the iron a little; then clean, oil and burnish. The blue color on wrought iron and steel is also produced by various other processes; it is, in some cases, due to a certain amount of oxidation corresponding to a definite amount of heat. For practical details of bluing see our issue of October 2, 1890.

(145) C. M. C., ——, asks: Can you tell me where I can get any writings on perpetual motion; also how far any one has succeeded in that line, and what is the nearest thing to perpetual motion that has been found? *A.*—We do not now recall any publications on the subject that would be of any value, though the subject has been discussed in our columns occasionally. No device can be properly said to be any nearer perpetual motion than any other device.

(146) S. R. L., Chicago, Ill., writes: Please inform me what books, and by what authors, treat on the subject of compound and triple-expansion engines. *A.*—"Manual of Marine Engineering," by A. E. Seaton, is a good book. Although this treats wholly on marine engines, the principles involved are also applicable to stationary engines. The articles treating on compound engines, by James Tribe, recently published in our columns, are also valuable to designers of this class of engines.

(147) W. C. W., Pittsfield, Mass., asks: Do you know of an attachment to drill press for producing square holes? They are made in three sizes, and I saw them in use in a prominent tool shop in Connecticut. *A.*—You probably refer to the geometric boring and turning tool. This is manufactured by the Geometric Drill Company, Knickerbocker Building, Philadelphia, Pa. It is intended to be used as an attachment to a drill press for boring any geometrical figure, such as round, square, hexagon, octagon, etc.

(148) R. H. K., ——, asks: 1. How are the rifles cut in rifle barrels? *A.*—Usually by means of special machines arranged with a bar which is alternately pushed through and drawn out of the barrel, the cutting tool placed at the end of the bar cutting on the return stroke. The bar is rotated to give the proper spiral. 2. Will an ordinary steam gauge register water as well as steam pressure? *A.*—It will, though special gauges are made for water pressures, which usually register higher pressures, and are graduated to indicate feet of head.

(149) W. D. C., Worcester, Mass., writes: Please give me the name or names of books or papers which treat on steam, water and gas fittings, and address of publishers. *A.*—*The Engineering Record*, 277 Pearl street, New York, we believe, has published books relating to the subjects mentioned. Write to the above for catalogue. 2. What allowance in inches is generally made from centers of elbows, tees, couplings, etc., of various sizes in making up the length of pipes? *A.*—We see no other way than to measure the elbows, couplings, etc., and make such allowance as your good judgment may dictate.

(150) Machinist, Worcester, Mass., writes: Referring to your reply to inquiry No. 83 in the issue of February 23, current volume, I wish to be informed if the axis of the boring bar could possibly intersect the center line of lathe under the conditions named, which are that the axis of the boring bar for its entire length is set over and held in position on one side of center line of lathe while doing its work. *A.*—Under the conditions named in the question to which you refer, the axis of the boring bar intersects the center line of lathe at the point of the center in the head-stock. But we may go further, and say that even if these lines did not intersect, so long as the boring bar is not parallel to the line in which the cylinder which is to be bored travels, and the cutting point of the tool always lies in one plane perpendicular to the boring bar, the hole bored will be elliptical.

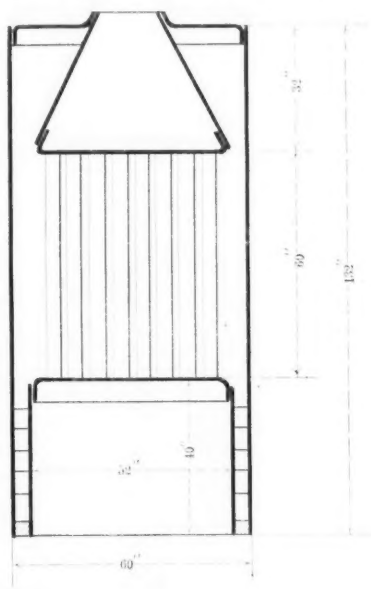
(151) R., Norristown, Pa., writes: I have a return tubular boiler burning bituminous coal. The boiler is 48 inches diameter and has 44 3-inch tubes 16 feet long, and the grate surface is 54 inches square. The stack does not draw sufficiently, and I am going to put up another one. Kindly give me the area and height of stack, and also state whether the grate surface is large enough? *A.*—The grate surface is about correct; it is none too large. The chimney proportions will depend on the amount of coal burnt per hour. Assuming that 15 pounds of coal per square foot grate surface are burnt, you will require a chimney 25 inches diameter and 80 feet high. 2. Please give me the exact horse-power of this boiler. *A.*—We have repeatedly drawn attention to the fact that the term horse-power of a boiler is a very vague one. See answer to Question 97.

(152) A. M. L., asks: Has steam heat been tried for baking foundry cores, and if so, with what success? *A.*—There are numbers of steam-heated ovens in this country, and I rather think we are to some extent indebted to Europe for the idea, which consists simply of piping direct from the boiler to the oven, where a valve controls the amount of steam allowed to enter a system of coils; which latter constitute the core shelves as well, being set somewhat slanting for drainage. Sixty pounds steam pressure in the coils gives temperature 250°, which will dry ordinary cores without the possibility of burning them; an increased pressure will, of course, give greater heat. Ventilation is perhaps best secured by a somewhat loose-fitting door, and an outlet at the bottom of the wall.—[S. BOLLAND.]

(153) H. P. T., Brooklyn, N. Y., asks: Will a 5 horse-power engine running at the rate of 1,350 revolutions per minute, driving a worm-wheel of 11 teeth with a worm on its shaft driving another worm-wheel of 11 teeth, be a practical and economical way of reducing the speed and holding a load of 2,000 pounds on a 20 inch drum? *A.*—We do not favor the idea of using two worms and two worm-wheels, each having 11 teeth only. The better way will be to use one worm and wheel with 121 teeth; this will reduce the speed of load in the same ratio. There are many cranes geared in this way, and for small loads it is practical; although the power lost in overcoming the friction between the worm and wheel is greater than with other gears, it is frequently deemed advisable to sacrifice this extra power, so as to obtain simplicity in the gearing and for holding the load safely in any position. 2. What would be the best pitch of teeth to use? *A.*—Pitch 1¼ inch.

(154) W. B., Pittston, Pa., writes: Please inform me of the proper way to determine the length of links for engines. *A.*—In determining the length of Stephenson's link, the first thing to do is to find the distance between the centers of the eccentric rod pins. The usual practice is to make this distance equal to 2¼ to 2½ times the throw of the eccentric, and occasionally, when space permits, to 3 times the throw. By "throw" is meant twice the eccentricity of the eccentric. The distance should not be much less than here given, because decreasing it will increase the slip of the block in the link; on the other hand, the design of the engine and the conditions under which it has to work usually puts a limit to this distance. For the length of the link add to the distance as found above the length of the link block, and sufficient clearance for the slip of the block, the sum will be the length of the link. This refers to the ordinary open or slot links, the length of the link being the length of the slot.

(155) E. P. P., Dickey, Ga., writes: I wish to put in a new upright boiler, with submerged head. The boiler is to be 60 inches diameter and about 11 feet high. Please give the proper dimensions of such a boiler, with size, number and length of tubes, thickness of shell and tube sheets. I wish to use this boiler in my machine shop, and would like to know what would be the objections, if any, to this style. Could this boiler be made of one sheet? Please give me a sectional view of such a boiler. The boiler is to carry a pressure of 150 pounds. *A.*—The accompanying sketch shows the general design of the boiler. In-



side diameter of fire-box, 52 inches; 40 inches high; sixty six tubes 3 inches diameter, 60 inches long; thickness of furnace sheet $\frac{5}{16}$ inch, tube sheets ½ inch thick; outside shell ½ inch thick, of steel, double-riveted, with welt piece inside. If you can get a good sheet 11 feet wide there is no objection to making the shell of one sheet. The objection to this type of boiler is, that one as large as this is not considered to be as economical as other types. 2. Please explain clearly how to compute the horse-power of such a boiler. *A.*—See answer to Question 97 in our issue of March 2, current volume.

(156) J. F. W., Philadelphia, Pa., writes: Kindly work out the answer to Question 504 in your issue of November 24, 1892. Give reasons for the same, so as to enable me to compute the horse-power of other engines. In the case referred to I make it considerable more than you do. *A.*—When we are asked to give the power of an engine working with an ordinary boiler pressure, say from 70 to 100 pounds, without knowing the exact point of cut off, clearance, etc., we generally take for the mean effective pressure per square inch of piston one-half of the boiler pressure. Hence in this case the mean effective pressure will be 45 pounds. Then applying the customary formula, namely,

$$I.\ H. = \frac{P \times L \times A \times N}{33{,}000},$$

in which P denotes the mean effective pressure in pounds per square inch; L the length of stroke in feet; A the area of the piston in square inches, and N the number of strokes per minute, which is equal to twice the number of revolutions per minute. According to the data given in the question referred to we have

$$\frac{45 \times 2.5 \times 113.1 \times 200}{33{,}000} = 77$$

indicated horse-power. This result we generally take to be indicated horse-power for non-condensing engines, but in this case we had reason to believe that the cut off occurred at a comparatively early part of the stroke, and we therefore said that this was the horse-power of a condensing engine. Calculations of this kind are at best an approximation only.

(157) O. A. F., Fairhaven, Mass., writes: About what area and height of chimney do I need for a 50 horse-power boiler? *A.*—The term horse-power of a boiler is a very indefinite one, and cannot be used for finding the dimensions of the chimney. The better way is to state the number of pounds of coal burnt per hour. If 4 pounds of coal per horse-power per hour are used, then $50 \times 4 = 200$ pounds of coal per hour will be burnt, and for this amount a chimney about 23 inches diameter and 60 feet high, or 21 inches square and 60 feet high, will be required. For finding the suitable dimensions of chimney for any other quantity of coal to be burnt, see table of chimney proportions in our issue of April 23, 1887. 2. Is it practical, in a case where an engine is close to a river, to lead the exhaust pipe into the river for the purpose of condensing, and connect the air pump to the return end? *A.*—It can be done, but the practicability of this arrangement will depend much upon the current; if the current is sluggish you may require a greater amount of cooling surface than is desirable to put in the river, and if the river is navigable these pipes may be in the way and exposed to injury. If the current is swift, and the pipes are not exposed to injury, and if there is a certainty that the water in the river will never be too low for the purpose of condensation, such an arrangement will give good results. But when repairs and everything else is considered, the chances are that a condenser above ground, with circulating and air pumps attached, will be more satisfactory.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Grant Gears. Lexington and Phila. See page 11.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Ideal Drawing Stands. M. C. Hammett, Troy, N. Y.

Forming Lathes Mer. Mach Tool Co., Meriden, Ct.

Tool Holder: Armstrong Bros. Tool Co., Chicago.

Norway Rivets, Evans & Robertson, Cincinnati, O.

6 Spindle Turret Drills A. O. Quint, Hartford, Ct.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Pattern and Brand Letters. A variety of sizes and styles. Heber Wells, 8 Spruce St., New York.

Drill Presses, with Tapping Attachments.
Gould & Eberhardt, Newark, N. J.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty St., N. Y.

Selden Packing for stuffing box, with or without rubber core Randolph Brandt, 38 Cortlandt St., N. Y.

Pulley lathes, most efficient offered. The Lodge & Shipley Machine Tool Co., Cincinnati, O.

Engine Castings, Humphrey's Foundry, Bellefontaine, O.

Air Compressors for every possible duty. Clayton Air Compressor Works, 43 Dey Street, N. Y.

For Cypress Tanks and Vats, address W. E. Caldwell Co., Floyd and Main Streets, Louisville, Ky.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

"Shapers (Double Triple Quick Stroke")
Trade Mark.
Gould & Eberhardt Newark, N. J.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker St., Philadelphia, Pa.

For best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs, Back-Pressure Valves, T. Kieley, 11 W. 13th St., N. Y. Send for des'n.

For the Latest Improved Diamond Prospecting Drill address the M. C. Bullock Mfg. Co., corner Canal and Washington Sts., Chicago, Ill.

Combination, duplex and special gear cutters in stock and to order. vertical milling machines. R. M. Clough, Tolland, Conn.

Gear Cutters, Auto. Specially adapted for Motor Gears and all other style Gears.
Gould & Eberhardt, Newark, N. J.

Sidney, Ohio, offers cash inducements to manufacturers to locate. Iron manufactories preferred. Correspondence with responsible parties solicited. J. K. Cummins, Secretary Improvement Board.

Patent Soliciting of High Class.
D. Walter Brown, Counsel in Patent Cases,
31 Nassau Street, New York.
Send for Brie History of Patent Legislation.

De Lamater Screw Propeller Wheel, made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUBLISHING CO., 203 Broadway, New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 postpaid. Published by John Wiley & Sons, 53 East Tenth Street, New York.

Marine Propulsion—III.

BY I. MCKIM CHASE.

It is generally believed by those uninformed in the matter that the resistance a vessel experiences to movement is derived wholly from the water and air through which it moves. This opinion, however, is erroneous. A considerable proportion of the energy expended in the movement of a vessel is absorbed by the weight of the vessel itself.

A vessel weighing 7,400 tons, moving with a velocity of 21 knots per hour, contains 144,485 foot-tons of energy. Assuming the speed to be unaffected by currents of water or wind, there is no other source from which this energy can be derived than that of the power developed by the engines of the vessel.

It will be interesting to consider the man-

ner in which the energy driving a vessel is expended, dealing with the weight of the vessel alone, and eliminating all other resistances. I will select the data from that of a modern high-speed naval vessel, in which the displacement of the vessel is 7,400 tons, the speed 21 knots per hour, and driven by three screws, the middle one of which is 14 feet, and the outside ones 15 feet diameter, each screw having a uniform pitch of 20.5 feet.

Suppose the vessel to start off, and with a uniform accelerated velocity acquire in five minutes a speed of 21 knots per hour, and then settles down to that uniform speed. It is required to determine the thrust necessary to accomplish this result; 21 knots per hour are equal to 35.46 feet per second, and as this speed is acquired by uniform acceleration in 300 seconds, the speed gained will equal

$$\frac{35.46}{300} = .1182 \text{ feet per second.}$$

As uniform accelerated velocity is compared to the action of gravity the constant thrust during the time the vessel is acquiring her maximum speed is readily obtained. It will equal

$$32.2 : .1182 : : 7,400 : 27.16 \text{ tons.}$$

The momentum of the vessel when maximum speed is acquired will equal

$$\frac{7,400 \times 35.46}{32.2} = 8,148 \text{ tons.}$$

The amount of thrust during the time the vessel is acquiring her maximum speed will also equal

$$27.16 \times 300 = .8148 \text{ tons.}$$

The propellers are to make 130 revolutions per minute. If the vessel remained fast while the propellers revolved, they would operate simply as pumps receiving the water at one end, and discharging it at the other with their pitch velocity.

When the vessel advances 35.46 feet per second, the pitch velocity of the screws at 130 revolutions per minute will equal 44.416 feet in the same time. The water will then be displaced, and moved sternward with a velocity of

$$44.416 - 35.46 = 8.956 \text{ feet per second.}$$

This amount is what is known as the slip of the screws, to abolish which is the ignisfatuus of a large majority of those who seek to make the screw propeller a more efficient instrument of marine propulsion than it is.

The mean speed of the vessel while acquiring her maximum will equal

$$\frac{35.46}{2} = 17.73 \text{ feet per second;}$$

the distance traveled while acquiring maximum speed will equal

$$17.73 \times 300 = 5,319 \text{ feet.}$$

Hence the work done in that time will equal

$$5,319 \times 27.16 = 144,464 \text{ foot-tons,}$$

and the rate of work done will equal

$$\frac{144,464 \times 2,240}{5 \times 33,000} = 1,961.14$$

horse-power per minute.

It has been shown according to the principle of momentum that when a thrust of 27.16 tons exists, there must be an equal opposite pressure at the same time. This opposite pressure is impressed upon a mass of water by the screws, which causes it to move sternward with a velocity equal to the difference of the velocity of the vessel and the pitch velocity of the screws, which difference is 8.956 feet per second.

It is now required to find the weight of this water displaced by the propellers necessary to accomplish the thrust. It will equal

$$\frac{27.16 \times 32.2}{8.956} = 97.64 \text{ tons.}$$

The water displaced by the screws does not receive its greatest velocity at once, but acquires it by uniform acceleration. Hence its mean velocity will equal

$$\frac{8.956}{2} = 4.478 \text{ feet per second.}$$

The distance moved through during the time the vessel is acquiring maximum speed will equal

$$4.478 \times 300 = 1,344 \text{ feet.}$$

The work done will equal

$$97.64 \times 1,344 = 131,229 \text{ tons.}$$

The rate of work will equal

$$\frac{131,229 \times 2,240}{5 \times 33,000} = 1,782$$

horse-power per minute. It is thus shown that

$$1961.14 + 1,782 = 3,744$$

horse-power per minute is expended in moving the weight of the vessel alone at a 21-knot speed,

The foregoing elucidates the theory of marine propulsion as expounded by Prof. Rankine, and accepted by the engineering profession as correct. It is correct as far as it extends. But there is another source from which thrust is obtained, which that profound investigator failed to comprehend, and which is to-day but little recognized, although it has been the means of making the screw the most efficient instrument of marine propulsion, and has brought into use screws of smaller diameter and greater velocities of rotation. This source is the inertia of the water, the resistance it offers to being started from a state of rest, and which will increase with the velocity with which the screw-blades come in contact with the water The same kind of resistance that prevents a shot from penetrating when it strikes the water and causes it to ricochet. The same kind of resistance that enables air to furnish resistance sufficient for the gases of nitroglycerine to destroy granite.

It is this factor that has made the subject of marine propulsion such a complex problem, and has baffled the efforts of investigators to devise formulas that are universally applicable. The writer is not aware of any method by which this resistance can be quantitatively determined. The formulas now employed in problems of marine propulsion are purely empirical.

If it was not for the inertia of the water, and the thrust depended wholly on the reaction of the water displaced by the propellers, the latter at 130 revolutions per minute would not be able to produce the amount of thrust estimated to exist when the vessel under consideration is traveling at a 21-knot speed, as the writer will endeavor to demonstrate.

The maximum estimated thrust is 48 tons on the collars of each shaft, making an aggregate of 144 tons for the three screws. The aggregate disk or athwartship area of all the screws is 507 square feet. Deducting for the bosses and blades, the combined effective area of the streams acted upon by the screws will probably equal 460 square feet. If every particle of the water displaced by the screws moved sternward parallel with the axes of the screws, which is by no means the case in practice, the amount so moved, assuming 34 8 cubic feet of sea water per ton, will equal

$$\frac{8.956 \times 460}{34.8} = 118.35 \text{ tons per second.}$$

The reaction or thrust resulting from this displacement will equal

$$\frac{118.85 \times 8.956}{32.2} = 32.917 \text{ tons,}$$

but little more than that necessary to move the weight of the vessel alone at maximum speed.

It is believed by many of those not informed in the principles of marine propulsion that a jet of water made to issue from an orifice in a vessel at a high velocity is a more efficient means of propulsion than that of a screw propeller. This is an erroneous opinion, however, as has often been demonstrated in practice. A theoretical comparison of the economical performance of the jet and screw systems of propulsion is easily made.

Suppose three sets of pumping engines to be substituted for those of the screws previously considered, and each pump discharges its water with a velocity of 100 feet per second from an orifice of 1.0138 square feet in area, or 1.135 feet diameter. The combined area of the orifices will equal 3.0414 square feet. Then there will be discharged in one second a column of water containing

$$3.0414 \times 100 = 304.14 \text{ cubic feet,}$$

which will equal in sea water

$$\frac{304.14}{34.8} = 8.74 \text{ tons.}$$

The reactionary effect or thrust resulting from the projection of this mass will equal

$$\frac{8.74 \times 100}{32.2} = 27.16 \text{ tons;}$$

the same amount of thrust that was obtained with the application of the screws where 97.64 tons were projected with a velocity of 8.956 feet per second.

The kinetic energy in a moving mass varies as the square of the velocity of the mass. As all the energy in the discharged water must be supplied by the engines, the difference in the amounts of energy contained in the discharged water in the two examples will denote their relative economies.

In the case with the screws, the energy in the discharged water will equal

$$\frac{97.64 \times 8.956^2}{64.4} = 121.6 \text{ foot tons.}$$

In the case with the jets, the energy will equal

$$\frac{8.74 \times 100^2}{64.4} = 1,357 \text{ foot-tons.}$$

Thus to produce the same effect, it has required more than eleven times the amount of energy to be expended with the application of the jets than with the screws.

"Petroleum Burner Patent Decision."

In our issue of February 23, we published, on what seemed good authority, the statement that a decision of the U. S. Circuit Court in the case of the Aerated Fuel Company *vs.* Cox & Sons Co., and others, was in favor of the former company, to the extent of covering the right under this company's patents to "all apparatus for burning hydrocarbon liquid in the presence of compressed air when the liquid and air are supplied to the burner through separate conduits, and the degree of compression of the air is automatically regulated."

Referring to this the Cox & Sons Co. write us that the decision was by no means as sweeping as our item made it appear to be. They also send us a copy of a statement from their attorney, in which, amongst other things, he says: "The Court * * * *did not* decide that you were not entitled to use automatic means for regulating the pressure of air. * * * I have no hesitation in saying that the regulating appliances which you have recently used are entirely outside of any possible construction of the Bullard Patent."

Information Wanted as to Reduction of Hours of Labor.

Some readers of the American Machinist are interested in knowing to what extent, if any, the regular hours of daily labor in machine shops have been reduced below ten. We would like to receive information on this point, either from proprietors or workmen connected with shops in which such reduction may have taken place, and will treat such information as confidential, if desired.

A Brussels correspondent writes:

"We are concerned to know the speed at which adjustable shell reamers should be running.

"At what tangential, that is to say, exterior speed should a 2" shell reamer be running for boring steel, iron and cast-iron, and at what speed should the tool descend?

"As the answer to this question may be very interesting for many of the readers of your paper we venture to suggest this information be asked in one of your columns, so as to get at an average conclusion of the experience of practical men."

Mr. W. E. Crane, whom our readers know as a frequent contributor to our columns, has resigned the position of chief engineer which he has held for a good many years at the works of the Benedict & Burnham Co., Waterbury, Conn. Mr. Crane is an engineer and mechanic of extended experience, which he has well improved; we shall be pleased to hear of his success in any new field he may enter.

A Homestead (Pa.) dispatch announces that the Carnegie works there have ordered from Joseph Whitworth & Co., of Manchester, the largest forging press ever constructed. The total pressure possible to exert by the press is put at 16,000 tons. The cost will be about $1,000,000.

Manufactures

The cotton ginnery will be rebuilt at Savannah, Ga.

A syndicate is being formed at Camargo, Ill., to bore for coal.

The Salisbury Cotton-mills, of North Carolina, will put up additional machinery.

A company will be organized at Rome, Ga., to build a 10,000-spindle cotton factory.

A. E. Johnson, of Paxton, Ill., will move his hemp-mill to Beatrice, Neb., in a short time.

A company is to be organized, to enlarge and improve the New Berne (N. C.) Knitting-mill.

Lumber-mills will be operated at Black Rock, Ark. Capital stock, $30,000. James E. Atkinson, secretary.

A stave-mill company has been incorporated at Fulton, Ark. Capital stock, $50,000. E. G. Wilder, secretary.

New machinery is being added to the plant of the American Roofing Company, on Second and Barry streets, St. Louis, Mo

Fort White, Fla., will have a new canning factory, with a daily capacity of two thousand cans. D. E. Whetston is interested.

The horse collar pad factory at Lincoln, Ill., is considering an offer from Knoxville, Tenn., to move the factory to that city.

James A Taylor & Co., Wilmington, Del., issue a new catalogue of standard gauges, measuring instruments of precision, reamers, etc.

J. E. Snyder, Worcester, Mass., sends us catalogue matter relating to his upright drills; also a partial list of the parties who are using these drills.

Jones & Lamson Machine Co., Springfield, Vt., write us. We are now enlarging our works by the addition of a building 60x150 feet, two stories, to meet the increased demand for our 2 24 flat turret lathe.

The Acme Machinery Co., Cleveland, O., has issued a catalogue of bolt heading, upsetting and forging machines. It is finely arranged, well printed on superior paper, and the cuts do great credit to the engraver. The only regret one can have is that this catalogue is not of standard size—it is one-half inch too large each way. But as the cuts are none too large for the standard page, it will be easy to make it "standard" in future editions.

Machinists' Supplies and Iron.

New York, March 25, 1893.

Iron—American Pig—We quote Standard Northern brands, No 1 Foundry, $14.50 to $15.25; No. 2, $13.75 to $14.50; Gray Forge, $12.75 to $14. Southern brands of good quality are obtainable at $14.25 to $14.75 for No. 1 Foundry; $13.25 to $14 for No. 2; and $12.25 to $13 for Gray Forge.

Antimony—The market is steady. We quote L. X., 10⅜c. to 10½c.; Cookson's, 10½c. to 10¾c.; Hallett's, 10c. to 10⅛c., and U. S. French Star, 10⅛c

Copper—The market is dull Lake Copper is nominal at 11¾c. to 12c. Casting Copper is held at 10¾c to 11c.

Lead—The market is firm, with 4.05c. asked for prompt or near delivery. Some business is reported at this price.

Lard Oil—Prime City is quoted at $1 00 to $1.02.

Spelter—The market is firm; holders appear to be uniform in their views at 4.30c., but no important business is reported

Tin—The market is easier, with accumulation of supplies. There are sellers of prompt delivery at 20 40c. Some sales have been made at 20.75c. to 20 90c., and for May at 21c.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—Salesmen on commission, to push a special line of mach'y. "Kirk," care of Am. Mach.

Draftsman (designer), machine tools, fixtures and general mach'y, desires pos'n H. M., Am. Mach.

Wanted—Good metal model makers; good pos. to exp'd party. Thurman & Scullin, Indianapolis, Ind.

Mech'l draftsman, exp'd in hoist'g & mill mach'y, & plants, wants position; refs. Box 68, Am. Mach.

Competent job shop machinist desires position; good manager. Box 64, American Machinist.

A foreman pattern maker desires a change. Am posted on steam pump and engine work, etc. Address P., American Machinist.

Wanted - Situation by 1st class mech. draftsman & designer, 16 yrs' exp. in marine & sta'y eng. and gen. mach'y, 1st-class refs. furnished. 62, Am. Mach.

Wanted—An experienced and competent man as superintendent in a carriage hardware manufactory. Manufactures, Box 58, American Machinist.

Pos. wanted by young man, mach.; understands thoroughly manufacture of steam pumps; also the office work and selling of same. Box 54, Am. Mach.

First-class pattern maker desires situation as foreman; experienced in heavy machine tools, etc. Age, 36. Address Box 60, American Machinist.

Wanted—1st-class brass molder to take charge of foundry. State experience and salary. Apply James Morrison Brass Mfg. Co., Toronto, Ont.

Wanted—Pattern makers on heavy machinery work. None but 1st class workmen of good habits need apply. Farrel F'd'y & Mach. Co., Ansonia, Ct.

Wanted—Foreman for machine shop for a car works; must be under 40 years of age. Address V. 5, care Lord & Thomas, Chicago, Ill.

Wanted—Position as foreman in shop by man having large experience with tool and jig work; age, 28; references. Box 69, AMERICAN MACHINIST.

Wanted—Foreman for machine shop; fifty hands; engine building and general iron work. Address, with references. Box 66, AM. MACHINIST.

Wanted—Position by mechanical draftsman, 4½ years' experience; printing presses, general machinery, & heavy machine tools. D., AM. MACH.

Mechanical draftsman, good designer, neat and accurate worker, shop practice, wants to change present position. A. L., 417, AM. MACHINIST.

Wanted—A position as designer of electric motors for tools, fans, blowers, cranes, etc., by a thoroughly competent engineer. Box 67, AM. MACH.

Wanted—A coppersmith for general work; steady situation to a good man. Address, with wages expected, etc., Post-office Box No. 1630, Philadelphia.

Wanted—Foreman for smith shop; must be well up in his business, & a good manager; further particulars on applica'n to Frick Co., Waynesboro, Pa.

Situation wanted by mechanical draftsman (age 28), technical graduate, with 3 years' exp. as draftsman & 6 years' exp. as mach't. O. M. S., AM. MACH.

Wanted—A 1st-class tool and die maker for making punching dies. Permanent situation and good wages to the right man. Address Dupaul, Young Optical Co., Southbridge, Mass.

Wanted—Two or three 1st-class draftsmen. Must be good designers, and have had shop experience. Preference will be given to those having worked on electrical machinery. Box 56, AM. MACH.

Wanted—An exp'd man to take charge of a modern locomotive blacksmith shop. In answering, please give references, state age and experience, and salary expected. Smith, AM. MACH.

Wanted—A mechanical engineer, a graduate who has had some shop exp.; also 2 mechanical draftsmen exp'd in general engine and machine work. F. W. E., Room 40, Coal Exchange, Scranton, Pa.

A first-class mechanical draftsman, of 6 years' exp., would like position; N. Y. City pref'd; a tech. grad., understands small, automatic & interchangeable mach'y perfectly. Box 22, Williamsville, N. Y.

Foreman in iron foundry, one familiar with all kinds of light and heavy machinery in green dry sand and loam; best of references from last employer. Address C., AMERICAN MACHINIST.

Wanted—Draftsmen, two mechanical draftsmen, first-class men to work on machine tools, men with experience on this class of work preferred. P. O. Box 1527, Fitchburg, Mass.

Wanted—By a superintendent of machine, foundry and boiler works, a similar position after May 1st; specialties, hydraulic, sugar, steam and power machinery and ordnance. Box 71, AM. MACHINIST.

Mech. engineer exp'd in laying out plans of mach'y, making estimates, and supt'g construction of work, desires engagement as draftsman and asst. manager or supt. Box 46, AM. MACH.

Wanted—A practical machinist, well up on jig and tool making, and competent to take position of foreman of a small but well established and growing concern; manufacturing a specialty. Address P. S., AMERICAN MACHINIST.

Polytechnic graduate, having wide practical experience as designer and salesman of high-duty steam machinery, would like to represent first-class builder in New York office. References given. Address R. I. G., AMERICAN MACHINIST.

Wanted—A position; 12 years' experience in shop and drafting room work; at present hold position as superintendent of the Ferracute Machine Co.; a member of the A. S. M. E. Address Chas. D. Reeve, Bridgeton, N. J.

Mech. engineer wants situation as supt., assistant supt., or chief draftsman. 15 years' practical experience on machine tools, eng. and electric machinery; best refs. Theory & Practice, AM. MACH.

Wanted—One good draftsman accustomed to steam-engines and general work; must understand the steam engine thoroughly. State age, exp., habits and salary expected, and how soon you can come. Box 300, AM. MACHINIST, New York.

Wanted—Foreman for machine shop manufacturing wood-working machinery; must be a good mechanic, and well acquainted with modern machine shop practice; state age, experience, and salary expected. Address I., Box 26, AM. MACHINIST.

Wanted—Member A. S. M. E., superintendent of large works, desires similar position in Philadelphia about June 1st. 18 years exp. covering machine tools, general machine and iron work, & electric railroad & lighting mach'y. Box 59, AM. MACH.

Experienced draftsman and designer, who is also a thorough mechanic with large experience in charge of work and men, desires position as head draftsman or sup't, machine tools, engines or general machinery. Box 70, AMERICAN MACHINIST.

Wanted—Steady employment given to a good turret lathe hand in a large, pleasant Ohio town. Must be a temperate man of family and steady habits, and a good workman. Address L. B., care of AMERICAN MACHINIST.

We will pay 25 cents each for copies of the AMERICAN MACHINIST of December 4, 1886 issue; must be unsoiled and in good condition. AMERICAN MACHINIST PUBLISHING COMPANY, 203 Broadway, New York.

A man thoroughly experienced in first-class machine tool work and modern methods, capable of handling men to best advantage; a hustler of good and steady habits, to act as foreman; to the right man a good and steady job. Address, stating age, experience, reference, and salary expected, Box 65, AMERICAN MACHINIST.

Position as sup't or assistant sup't, by practical draftsman, machinist & diemaker, now engaged; press and die concern pref'd, thor'ly familiar with power presses and all kinds of cutting & perforating dies, Perf. machines, shoe dies & shoe mach'y; 12 years with one house; age 35; strictly sober and reliable. Anderson, AM MACHINIST.

HACKNEY HAMMERS

Meet all requirements more fully and satisfactorily than any other of its competitors.

INVESTIGATION IS NOT COSTLY.
INVESTIGATION IS CONVINCING.

WRITE FOR CATALOGUE TO
THE HACKNEY HAMMER CO.
20 Johnson St., CLEVELAND, O.

THE PERKINS DRAW STROKE TRIMMER,

An Indispensable Tool for all Bench Woodworkers. Latest and Best Design. Infringers Prosecuted. Trial, not orders, solicited.

PERKINS & CO., Grand Rapids, Mich
STOCKS, NEAVE & CO., Manchester, England

U. S. STANDARD
SHEARING
PUNCHES
For all kinds of Riveted Work.
I. P. RICHARDS, Providence, R. I.
New Illustrated Circular.

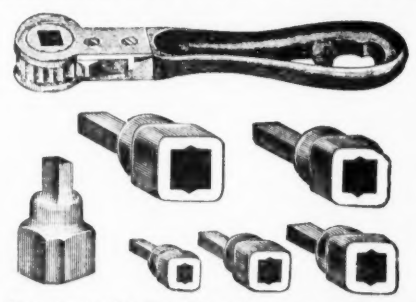
Bradley Hammers.

If you plate, draw, square, taper, swage, collar, spindle, or do any manner of die forging in iron or steel, a BRADLEY HAMMER will soon pay for itself, by what it will save over any other similar tool. Send for circulars.

BRADLEY & COMPANY, SYRACUSE, N. Y.

THE BEST WORKMEN ARE USING
GROBET SWISS FILES.
MONTGOMERY & CO.,
105 FULTON STREET, NEW YORK CITY.

IMPROVED
CLIMAX RATCHET WRENCH



Is so simple that its utility and convenience is at once apparent. The Sockets take Square and Hexagon Nuts, Set Screws, Cap Screws, Lag Screws, etc., for overhead work or in corners, close places, etc., it is a most useful tool. The Wrench is either right or left hand as desired, and is made of Malleable Iron and Steel. The Sockets are Malleable Iron. It is well made and nicely finished. Very useful to many classes of mechanics, and especially so to Machinists, Engineers, Millwrights, Car, Boat and Bridge Builders, Wheelwrights, Mills, Factories, etc., and all places where machinery is used. Very low in price. Sold by Jobbers everywhere.

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Books for Molders.
Dingey's Machinery Pattern-Maker.
12mo. Cloth. $2.
BOLLAND, THE IRON FOUNDER.
12mo. Cloth. $2.50.
JOHN WILEY & SONS, - NEW YORK.

Ready-made Gears.
Gears Made to Order.
Gear Cutting.
Gear Book, 15 Cents.
Geo. B. Grant,
Lexington, Mass.,
And 125 So. 11th St.,
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PASSAIC ART CASTING CO.
PASSAIC, N. J. NEW YORK OFFICE 33 WARREN ST.
Fine castings by new pressure process equal to hand cut work in Bronze, Brass, Aluminum, and German Silver. Machinery Name-Plates 1½ cents per sq. inch

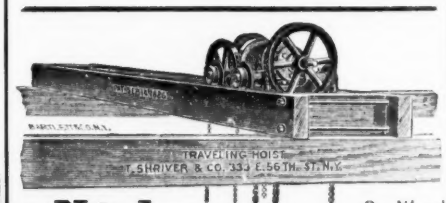
W. C. YOUNG M'F'G CO., WORCESTER, MASS.
Foot Lathes, Engine Lathes,
SHEARS AND PUNCHES.

Experimental Work of every Description,
Mechanical and Electrical. Contractors for the manufacture of specialties, or can furnish complete plants for their manufacture. Make Dies, Special Tools, Gauges, Drawings, Patterns, Models. Inventions perfected. Estimates furnished. Correspondence solicited.
Send for Circular of our SENSITIVE KNEE DRILL.
BRADY M'F'G. CO. 83 Washington St., BROOKLYN, N. Y.

Bowsher's BALANCING

WAY
FOR BENCH AND FLOOR USE. 8 SIZES AND STYLES.
A new idea. A time saver. A tool to take the place of the devices in present use for balancing pulleys, armatures, cutter heads and rotary parts of machinery in general. Ways are *chilled* and *ground*. Spirit levels attached. Substantial, accurate, cheap. Send for circular.
N. P. BOWSHER, South Bend, Ind.

ONLY 25 CENTS Stamps Accepted.
A Practical Little Book.
"HOW TO MAKE A 1 h. p MOTOR OR DYNAMO."
Illustrated with plans and all details.
Address, ELECTRICAL REVIEW, 13 Park Row, N. Y.



No. 1 TRAVELING CRANE. CAPACITY, 3,000. On Wood Overhead Beams.
PRICE OF MACHINE. - - $100.00
Timber, Bolts, Track Iron for overhead frame, 11.50
Send for Illustrated Circular, giving full details.
T. SHRIVER & CO. 333 E. 56TH ST. NEW YORK.

CHARLES MURRAY
ENGRAVER ON WOOD
58 ANN ST. NEW YORK

SOFT GRAY IRON CASTINGS.
From ⅛ oz. to 1000 lbs. Small Castings a Specialty. Light machinery wanted to build.
ONTARIO IRON WORKS,
CANANDAIGUA, N. Y.

Wanted Everywhere. Agents

Nonpareil Ratchet Wrenches.

Made of best forged Tool Steel; are easily and readily adjusted and controlled. Can be made reversible instantly without removing from their work by throwing over the lever in slot of the handle.

The Set of Combination Tools No. 1 includes the wrench, two sockets, one for screw-driver, bit or reamer shank, with wood handle and one socket for drill shank and feed nut. The jaws on this wrench open from 3/16 to 1¼ inches.

Send for Illustrated Circular and Price List of various sizes.
The Keystone Manufacturing Co.,
312 TERRACE, BUFFALO, N. Y.

BURNHAM'S DRILL.

SEND FOR CIRCULAR.
THE GEO. BURNHAM CO., Worcester, Mass.

HUGO BILGRAM,
440 N. 12th St., Phila., Pa.
Maker of all kinds of
MACHINERY.
Special facilities for Accurate Work.
Bevel Gears cut theoretically correct.

VANDERBEEK'S
NEW COUNTERSHAFTS.
NEW CONSTRUCTION,
NEW FRICTION AND SELF-OILING THROUGHOUT.
THE STATES MACHINE CO.
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MECHANICAL BOOKS.

We publish several mechanical books neatly bound in leatherette and which are authorities on the subjects treated. They are written in plain language. We have sold thousands to engineers. They are not filled with advertisements like most books of this class.

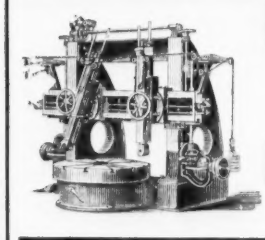
Key to Engineering, 92 pages, 30 cents. Plain questions and answers about steam.
Engineers' Epitome, 135 pages, 50 cents. More mathematical, with formulæ.
Common Sense in Making Steam, 60 pages, 25 cents. For owners of steam plants. The above three post-paid for $1.00. Stamps taken.
Engineers' Catechism, 192 pages, 25 cents. We have bought the copyright of this book, which is an authority, and was compiled for engineers about to pass examinations.
Key to Engineering (enlarged), 174 pages, 50 cents, containing additional chapters and tables.

Following are from Practical Engineers, unsolicited.

I ENCLOSE ONE DOLLAR for a set of your grand little books on steam, and some day want some of the good steam appliances you make.—A. W. BEACHER, RONDOUT, N. Y., Feb. 4, 1893.

I WOULD NOT SELL "Key to Steam Engineering" and "Common Sense in Making and Using Steam" for $10 if I could not get another.—WM. D. REES, PUEBLO, COLO., Sept. 24, 1892.

MASON REGULATOR COMPANY, Boston, Mass.
W. B. MASON, Superintendent. WALTER G. CHASE, Treasurer.



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ASBESTOS SECTIONAL PIPE COVERINGS.
Non-Conducting Coverings for Steam and Hot Water Pipes, Boilers, etc.
ASBESTOS BOILER COVERINGS.
H. W. JOHNS MANUFACTURING COMPANY,
H. W. Johns' Asbestos Millboard, Sheathings, Building Felts, Fire-Proof Paints, Liquid Paints, Asbestos Roofing, Etc.
87 MAIDEN LANE, N. Y. JERSEY CITY, CHICAGO, PHILADELPHIA, BOSTON, ATLANTA, LONDON.

Cost accounts are my specialty; gen'l office exp., quick and accurate draftsman; mach'y my line; large concerns address P. B. Cheek, Am. Machinist.

Junior member A. S. M. E., familiar with steam and hydraulic engineering, transmission, hoisting mach'y, roofs and bridges, blast furnace and rolling-mill work, pattern and machine shop practice, desires a position where attention to business will be rewarded by advar cement; age 33; ref. furnished. Address Junior, American Machinist.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers S. M. York, Clev'd, O.

Best Steel Flue Scrapers. Kelley Co., Erie, Pa.

For Sale—Second-hand drill presses, engine lathes and planers. Dietz, Gang & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Best Bolt Header in the world for $50. Address C. H. Baush & Sons, Holyoke, Mass.

London Engineering from commencement to date for sale. Address "Boston," Am. Machinist.

Boiler vertical and 3-horse engine, $67; screw cutting lathe, 16" swing, $120. 229, Am. Machinist.

For Sale—36" gear cutter, extra heavy, new; one 300 lb. steam hammer; one 16" monitor turret lathe. A. L. Henderer, Wilmington, Del.

For Sale—Upright engine, new, 5 horse-power, 5"x5" cylinder, and 30"x5 feet upright boiler, new. All guaranteed; only $181, spot cash. Wm. C. Codd, Baltimore, Md.

Wanted—To sell one of the most complete foundry and machine shop plants west of the Mississippi, located in the best town in the West; this plant is equipped with modern machinery and of large capacity; originally established in 1867; reason, wish to retire from business. R. L. Cofran, Topeka, Kan.

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GENERAL EASTERN AGENTS

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G. A. GRAY CO.'S Planers,
The Celebrated MULLER Lathes,
W. F. & JNO. BARNES CO.'S Drills and Lathes,
KELLY Adjustable Crank Shapers,
SMITH & SILK Crank and Geared Shapers.
DIETZ, GANG & CO.'S Radial Drills.

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GEO. H. EATON & CO.'S Power Presses and Shears,
SLATE MACHINE CO.'S Sensitive Drills,
DIAMOND MACHINE CO.'S Grinding and Polishing Machinery.

A Large Stock Always on Hand.

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LAICHT & CANAL STS.,
NEW YORK.

SECOND-HAND AND NEW MACHINERY

Planers.	62 in x9 ft.	2 Heads.	Planers.	31 in.x8 ft.	1 Head.
"	62 in.x22 ft.	1 "	"	30 in.x7 ft.	1 "
"	54 in.x24½ ft.	2 "	"	26 in.x7 ft.	1 "
"	42 in.x16 ft.	1 "	"	25 in.x5 ft.	1 "
"	36 in x12 ft.	1 "	"	24 in x5&6 ft.	1 "
"	22 in.x5 ft.	1 "	"	20 in x4 ft.	1 "
"	15 in.x3 ft.	1 "			

80 in.x18 ft. Engine Lathe Geared Face Plate.
60 in.x45 ft. Double Engine Lathe.
52 in x35 ft. Engine Lathe Horizontal Boring Machine, one end
30 in.x28 ft. Pond Machine Tool Co Shafting Lathe.
36 in.x16 ft. Engine Lathe
33 in.x27 ft. " "
32 in.x12, 14, 16, 18 ft. Bed. New Engine Lathe.
28 in.x22 ft. Engine Lathe, cheap.
25 in.x12, 16, 20 and 24 ft. Bed. New do do
24 in.x10, 12 ft. Bed. do do do
20 in.x7½ & 8 ft. do 2d Hand do do
18 in.x 6, 7 & 8 ft. do New & do do do
17 in.x 8 ft. do do do do
16 in.x 6 & 8 ft. do do do do do
15 in.x 6 & 8 ft. do do do do do
14 in.x 6 ft. do do do do do
Car Axle Lathe, Bement. | Driving Wheel Lathe 88 in.
15, 16, 18, 25 in. Crank Shapers. | Wheel Quartering Mach.
20, 24, 26 & 30 in. Geared Shapers. Double.
20, 22 24, 28, 30 & 36 in Drills. | No. 0 Turret Lathe, Am. Tool and Mach. Co.,
Bolt Cutters. | 24 in. Swing, N ft, Bed.
8 and 13 in. Stroke Slotters.
Lot of Lincoln Pattern Millers and No. 1 P. & W. Millers.
2 Spindle Drills. Garvin. No. 75 Bliss Press Geared.
O'Brien's Boiler Head Flanging Mach.; Gear Molding Mach.
1100 and 3000 lb. Bement Steam Hammer.
100 and 150 lb. Steam Hammer. | SEND FOR MARCH LIST
40 H. P. Vert. Engine. N. Y. S. S. P. Co.
11 in.x18 in. Hor. Engine. A1 Order.
14 in.x36 in.. 16 in.x42 in. Corliss and 16 in.x48 in. Brown Eng.

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120 BROADWAY, NEW YORK.

THE STANDARD REVOLUTIONS COUNTER
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PROVIDENCE, R. I. BOSTON, MASS.

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Patent Stop Motion. Registers 2,000 Revolutions

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MAY 1st to .

14 DEY STREET.

We will close out at low prices previous to time of our removal the following

SECOND-HAND MACHINE TOOLS.

Engine Lathe, 43 in. swg., 10 ft. bed—Screw Feed, Cpd. Rest. Price, $200.
Engine Lathe 24 in. swg., 5½ ft between—with Ck. and hollow spin., 1⅝ in. A1
Engine Lathe, 20 in. swg., 18 ft. complete with Ck. (Lathe & Morse). Good
Engine Lathe, 18 in. x 8 ft. complete. (New Haven).
" " 18 in. x 6 ft., " (Gage). Price, $115
" " 17 in. x 9 ft., " (Lathe & Morse). " $100
" " 16 in. x 7 ft., " (old style). " $50
" " 16 in. x 8 ft., " with Chuck, "modern style." A1
Chucking Lathe, 22 in. x 7½ ft. with Rest and Bars. Price, $60
Planer, 15 in. x 30 in. long, with Chuck, (Lathe & Morse). " $75
" 22 in. x 4 ft., complete, (Wood & Light). Good
" 24 in x 5½ ft., " with Chuck (New Haven). "
" 30 in x 8 ft., " latest pat., ex. heavy. Good as new
Shaper, 6 in.stroke, 22 in. feed, complete. Good. Price, $80
" 9 in. " "Crank Motion" complete. Good order
" 13 in " " extra heavy. "
" 13 in. " trav. head with 60 in. feed, complete, with two tables and circular feed, ex. heavy. Good order
" 14 in. stroke, friction, "late pattern. (Hendey). A1
" 20 in. " crank motion extra heavy. A1 order
Drill, 13 in wheel feed, (Putnam). Price, $35
" 20 in. " " new. " $55
" 32 in, back geared, auto. feed, and complete with reverse for tapping, extra heavy. Good as new
Gang Drills, 3 spindle, (Garvins). Good order. Price $70
Slotting Machine, 8 in. stroke, modern style, complete. Good
Key-seating Machine, for pulleys and wheels, all sizes, new pattern.
Brown & Sharpe No. 5 Screw Machine, 1⅜ hole, with auto. ck.
Brown & Sharpe Turret Chucking Machine A1 order
Bolt Cutter, 1½ in. revo. die head. Price, $50
Bolt Cutter, for accurate thread cutting, 1½ in., with dies and taps.
Eberhardt Tool Grinder, wheel 14 in., and pump. Price $60

J. J. McCABE,
SUCCESSOR TO
E. P. BULLARD'S
N. Y. Mach'y Warerooms.
68 Cortlandt Street,
NEW YORK.

JESSOP'S STEEL

FOR TOOLS, DRILLS, DIES, &C.

ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
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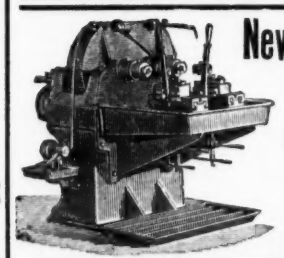

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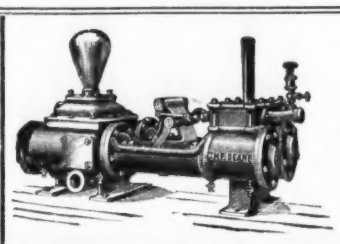

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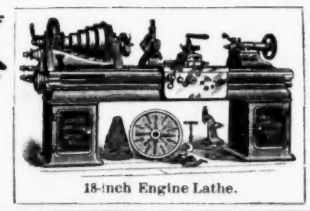

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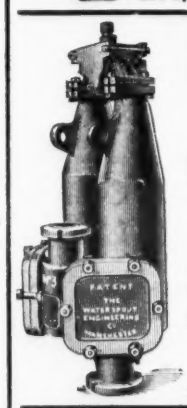

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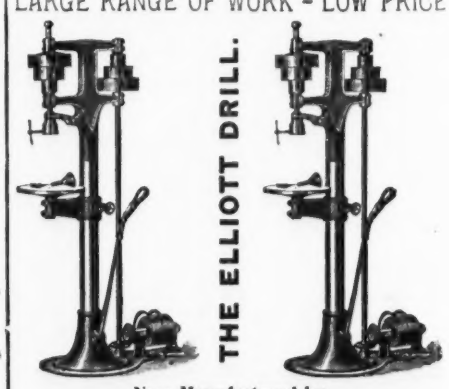

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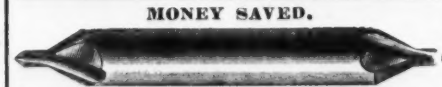

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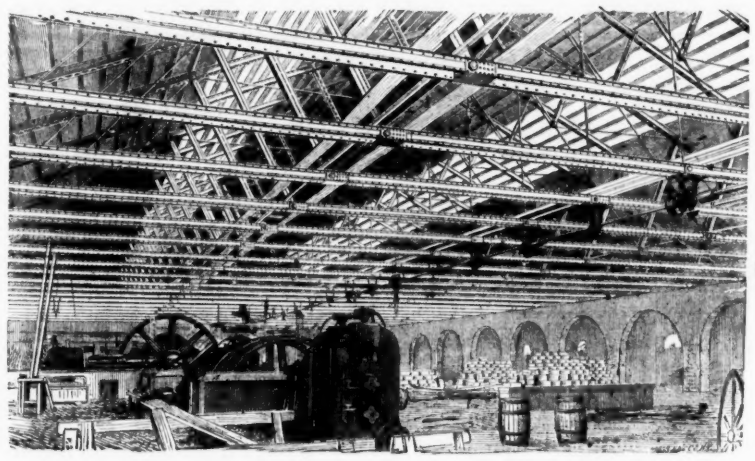

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11	1 3-4	1.10
12	2	1.30
13	2 1-4	1.35
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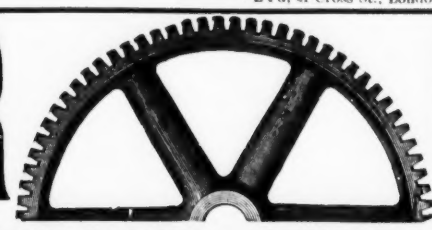

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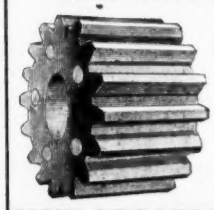

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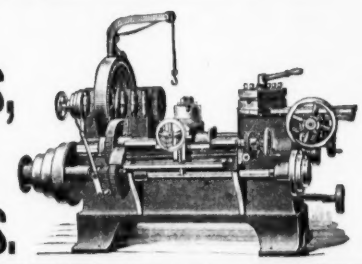

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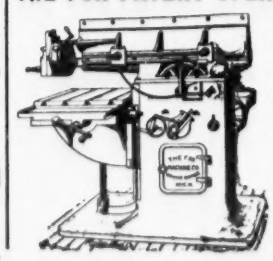

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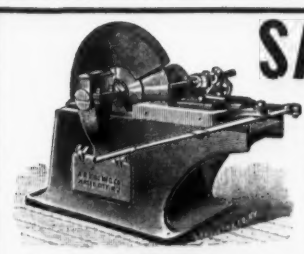

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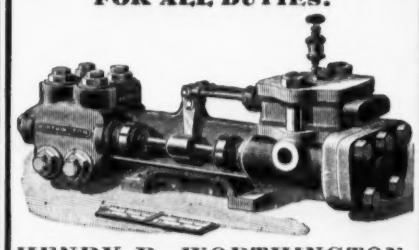

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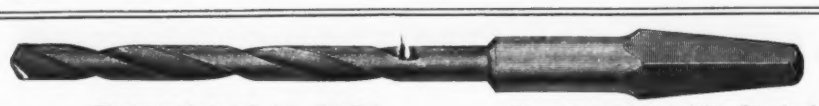

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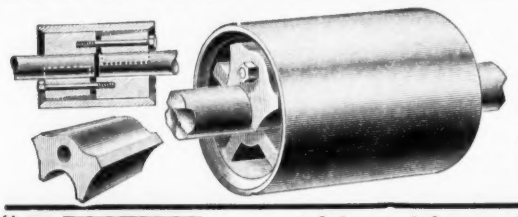

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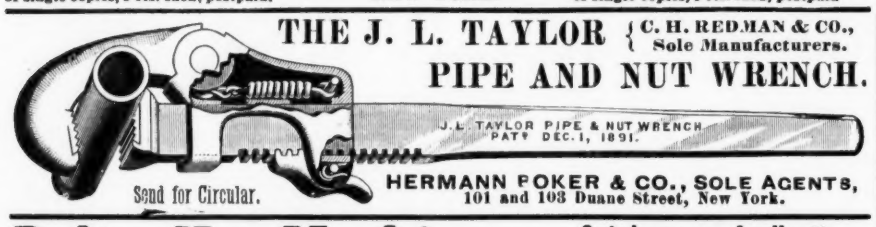

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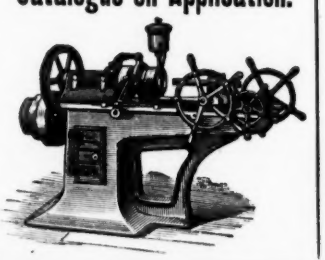

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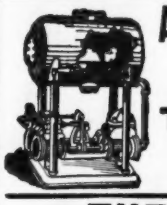

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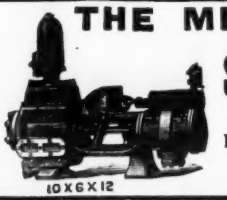

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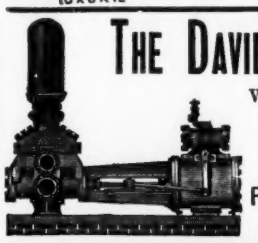

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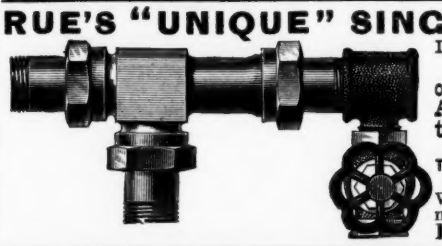

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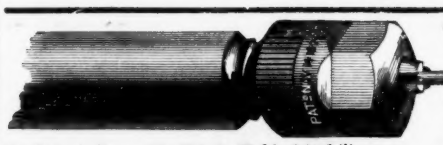

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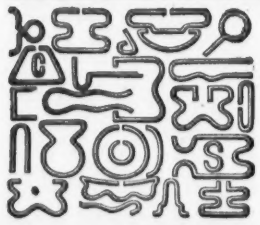

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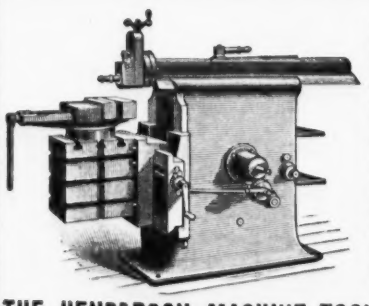

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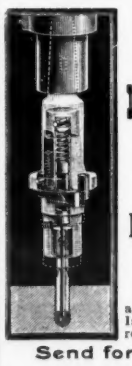

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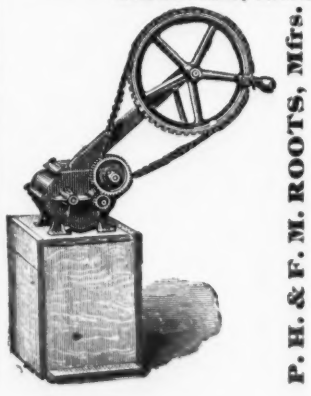

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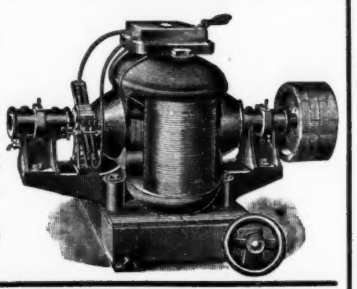

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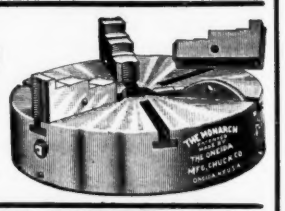

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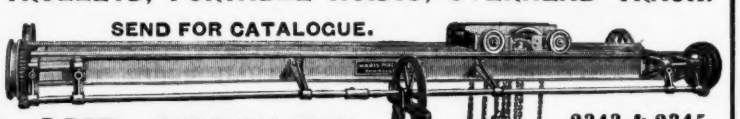

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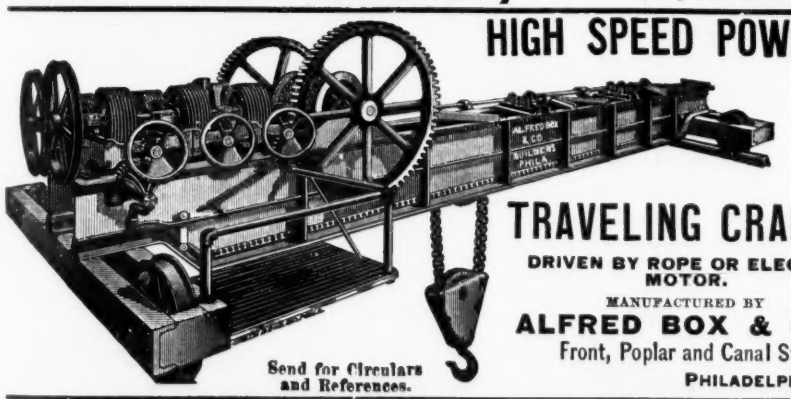

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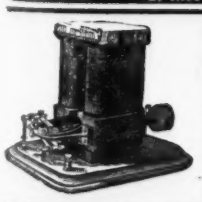

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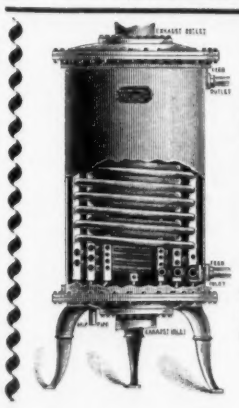

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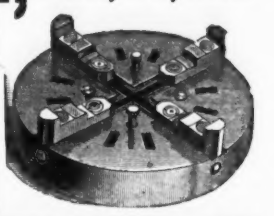
24 "	28 "
30 "	32½ "
36 "	40 "



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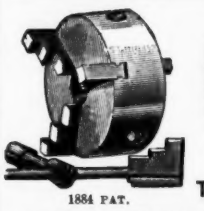

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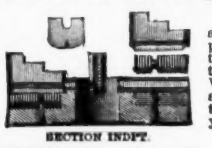

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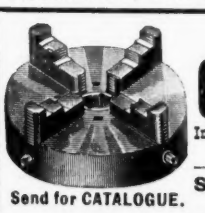

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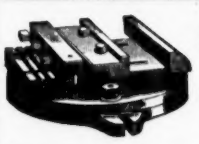

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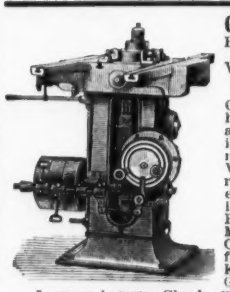

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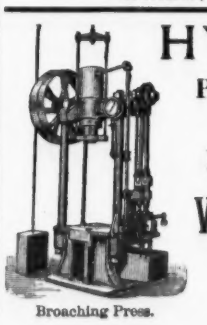

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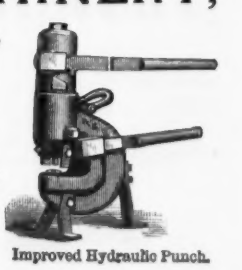

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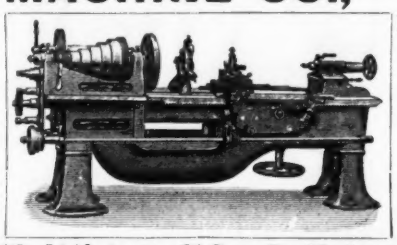

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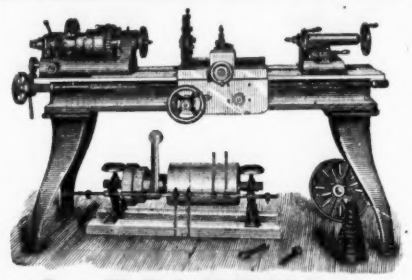

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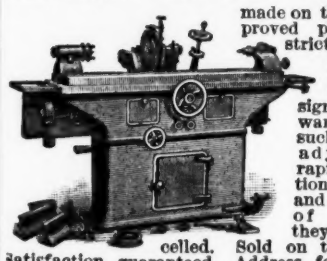

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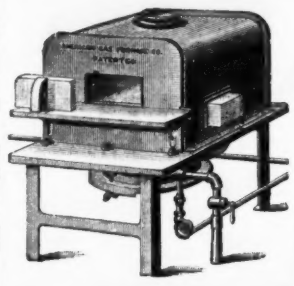

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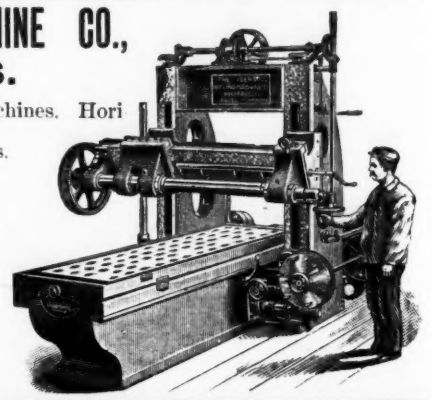

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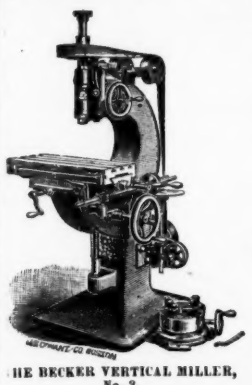

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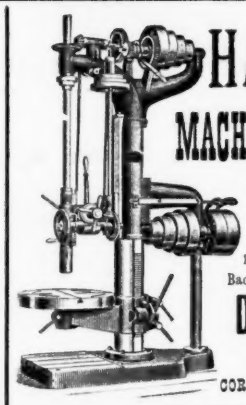

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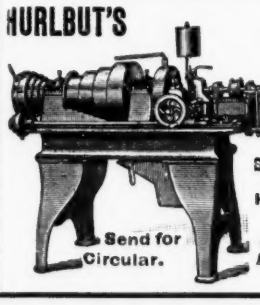

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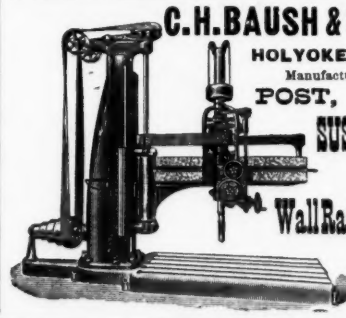

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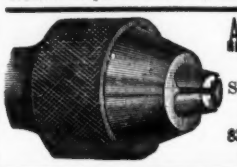

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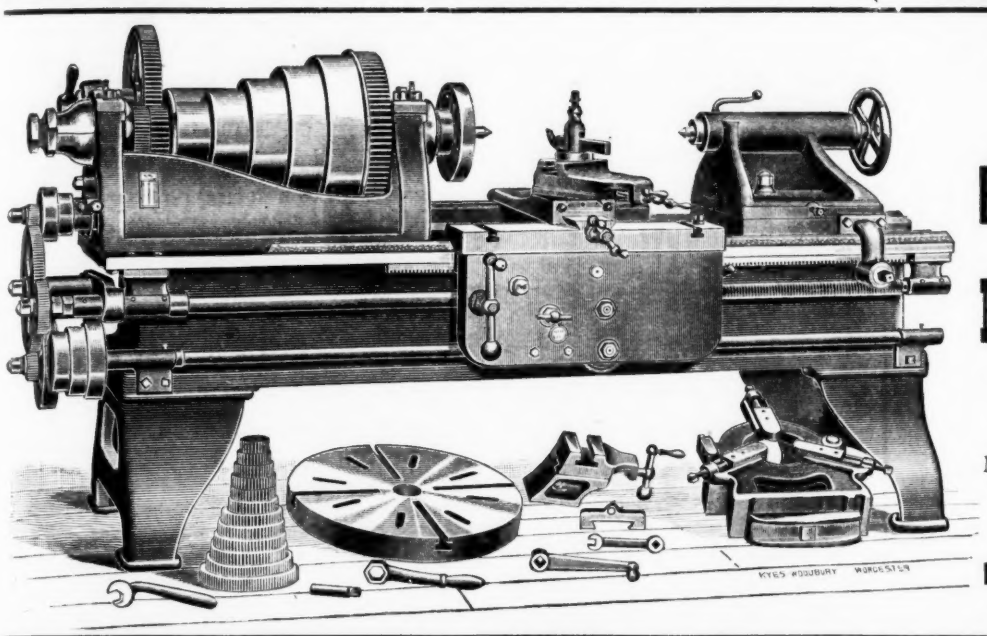

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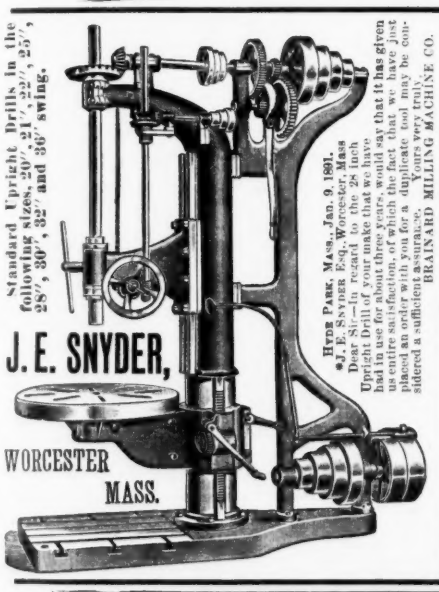

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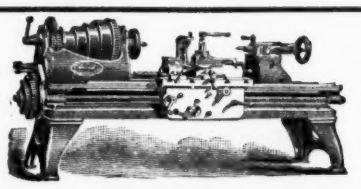

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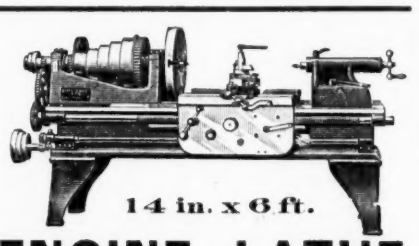

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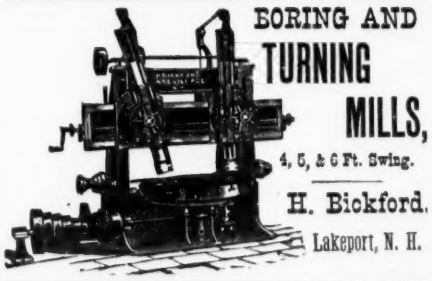

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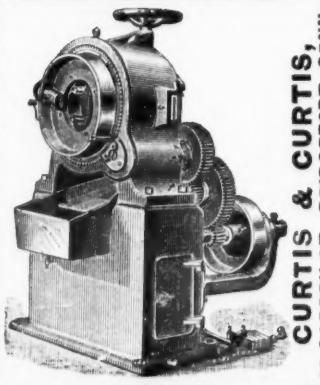

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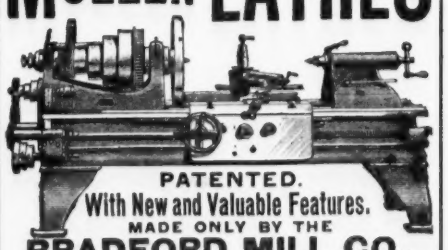

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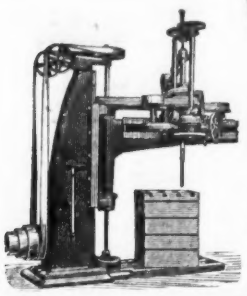

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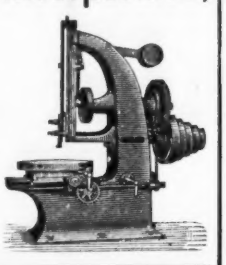

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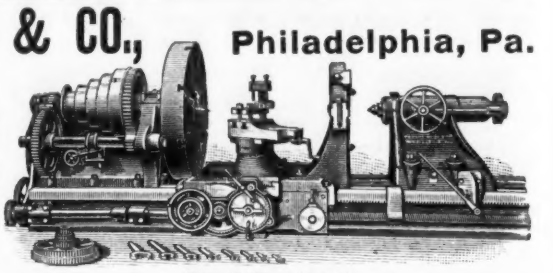

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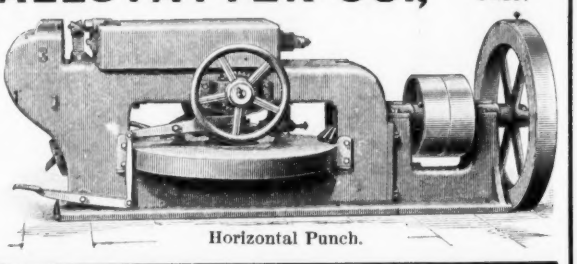

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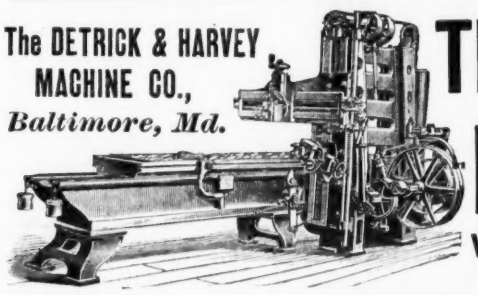

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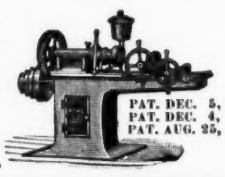

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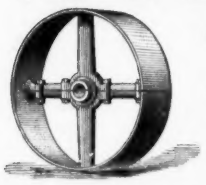

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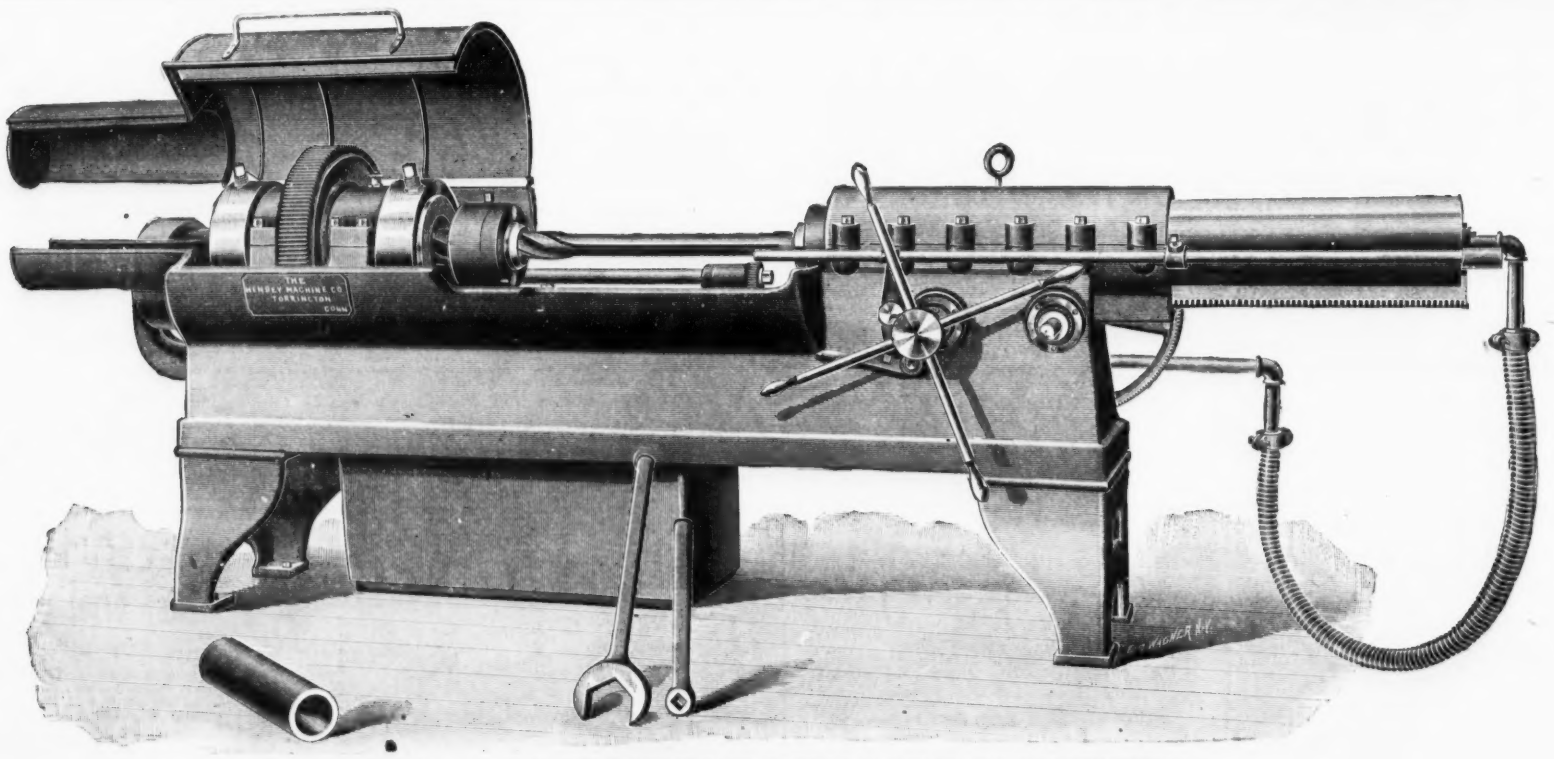

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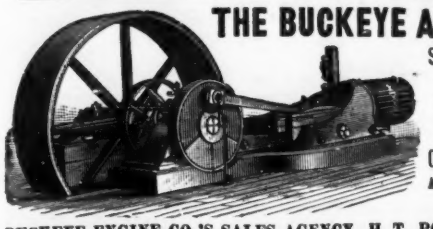

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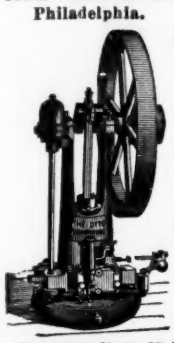

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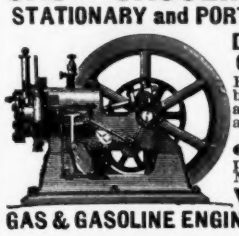

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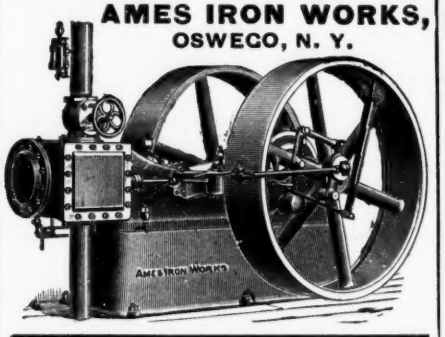

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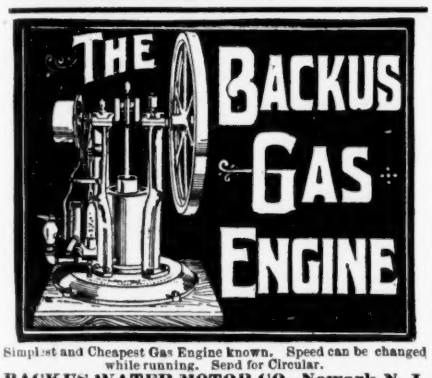

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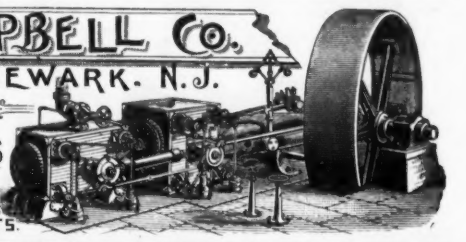

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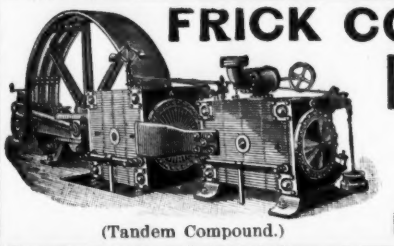

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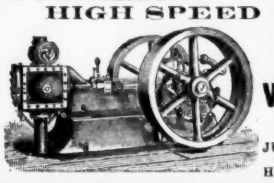

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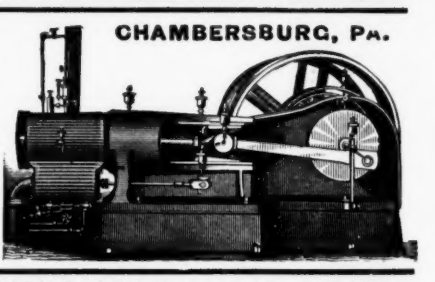

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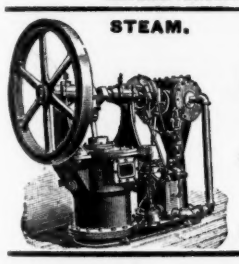
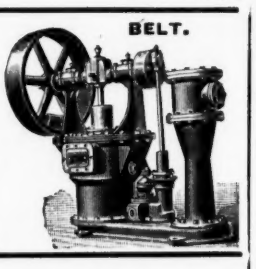


BELT.



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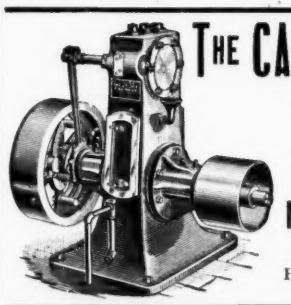

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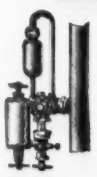

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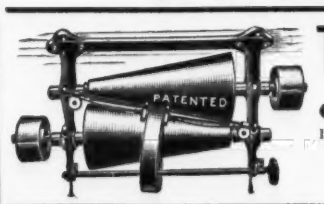

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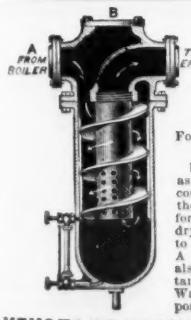

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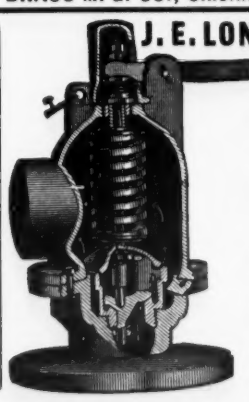

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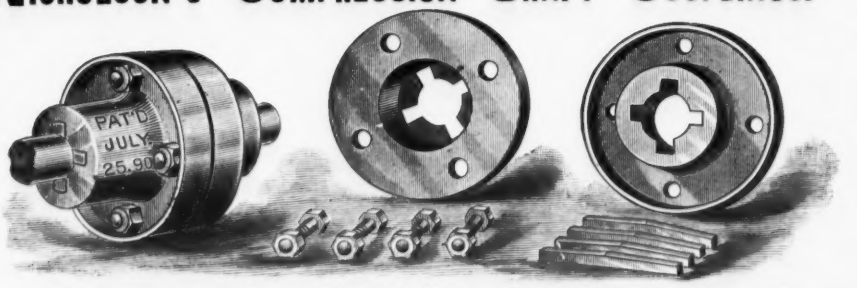

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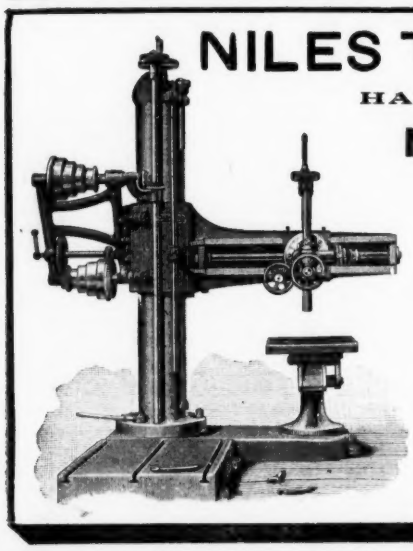

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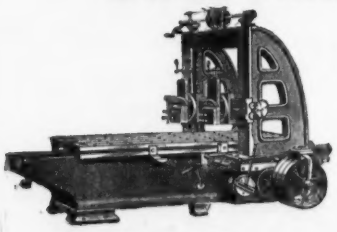

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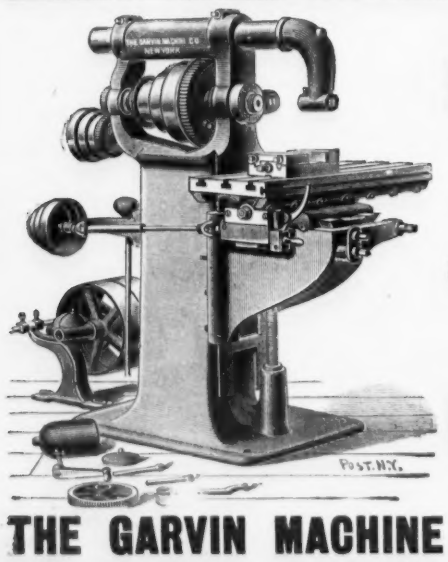

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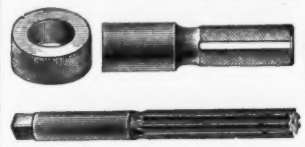

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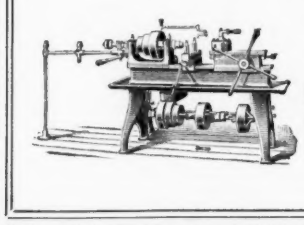

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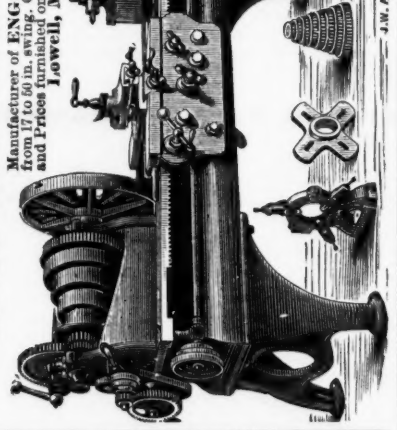

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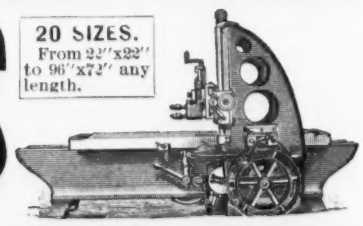

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